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DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR.

TWENTY-SEVENTH ANNUAL REPORT
OF THE
DIRECTOR
OF THE
UNITED STATES GEOLOGICAL SURVEY
TO THE
SECRETARY OF THE INTERIOR

1905-6

WASHINGTON
GOVERNMENT PRINTING OFFICE
1906

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TWENTY-SEVENTH ANNUAL REPORT
OF THE
DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

CHARLES D. WALCOTT, *Director.*

INTRODUCTION.

During the last fiscal year the character of the work and the organization of the force remained substantially the same as described in the Twenty-sixth Annual Report. Accounts of the work performed in geology and paleontology, chemistry and physics, topography and geography, and hydrography, hydrology, and hydro-economics, as well as in the lines of publication and administration, will be found on later pages.

Appropriations and allotments.—A plan of operations, including an itemized statement of the appropriations, amounting to $1,513,482.30, and the allotments thereof, was approved by the Secretary of the Interior on May 15, 1905. The work of the year conformed to this plan, copies of which are on file at the Department and the Survey.

State cooperation.—Many of the States, following a well-established policy, cooperated with the National Survey in geologic, topographic, and hydrographic work; details are given on pages 12, 29, 72, and 74.

INVESTIGATION OF FUELS AND STRUCTURAL MATERIALS.

The special investigation of the fuel resources of the United States, authorized by Congress in 1904, was continued during the last fiscal year on the same site in Forest Park, at St. Louis, with an allotment of $202,000. The general purpose of these investigations is the making of a series of comparative tests of representative coals and lignites from the important fields of the United States, the same equipment and methods of procedure being used in all cases except when modifications seem necessary in order to ascertain the highest efficiency in the utilization of special fuels. The equipment includes 2 boilers, 1 steam engine, 2 electric generators, 2 gas producers, 1 gas engine, all on an approximated 250-horsepower basis; a coal-washing and briquetting plant, a drier, a battery of 3 beehive coke ovens, and a well-equipped chemical laboratory. The samples of coal and lignite are collected by trained men employed for this work and are brought to the testing plant in lots of from 50 to 100 tons. The larger tests are supplemented by an elaborate series of chemical examinations of smaller samples from both the car shipments and the coal beds in the mine, the complete history of each of these samples being known. To June 30, 1906, the number of coals, lignites, and peats examined was 2,400; the number of boiler tests, 401; producer-gas tests, 119; coking tests, 218; washing tests, 102; briquetting tests, 54; chemical determinations, 12,878; miscellaneous tests, a considerable number.

The investigation of structural materials was conducted under the same supervision and at the same location as the fuel testing, the station supplying the necessary heat, light, and power for both. The allotment being small ($12,500), the work was necessarily confined to the completion of tests already begun and the beginning of limited additional tests of cement, concrete, and other constituent materials. In addition to this testing work, a general inquiry was instituted, at the request of a number of architects and engineers, into the present state of knowledge relative to the strength and other properties of building materials available for use in the United States. During May and June, with the cooperation of the War Department and the committee of engineers representing the American Society of Civil Engineers and associated organizations, an investigation was made of the effect of the earthquake and fire at San Francisco on buildings and building material. A report on these investigations will be published soon.

NEED FOR INCREASE OF APPROPRIATIONS.

Geology.—While the demands for geologic work in many localities and along many lines are increasing more rapidly than they can be met with present appropriations, they are specially urgent in two directions, for which an increase in the appropriation for geology of $50,000 is recommended.

The known iron-ore deposits in the United States are being rapidly absorbed, and there is keen competition on the part of the large iron companies in increasing their ore reserves. Such companies are fully aware of the value of expert geologic advice and are able to pay for it, but in order that any fair return may be received by present owners of ore lands reliable information regarding the occurrence and value of iron-ore deposits should be acquired and disseminated. The Government itself is directly interested, since extensive deposits of iron ore occur upon the public lands. These are being investigated as rapidly as possible, but the force employed for this purpose should be at least doubled.

The Government is the largest holder of coal lands in the world. These lands have up to the present been on the market, yet the Government has spent less in determining the value of its property than many private companies. It has been demonstrated that many millions of dollars can be saved to the Government by a geologic examination of its coal lands at a cost of less than 1 per cent of the amount saved. In view of the rapid development of western coal mining and the proposition to withdraw coal lands from sale in order to sell the coal itself on a royalty basis, there is an urgent demand for immediate accurate information, which the present appropriation is wholly inadequate to provide without sacrificing other important work in progress elsewhere. Requests for information regarding the extent, location, and value of coal on public lands have been received from the President and from the Senate (Senate resolution of June 29, 1906), which can not be adequately complied with, since the information requested is not in existence.

Topography.—No increase in appropriations for topographic surveys has been asked for the last two years, altho an increase was made by Congress for 1905-6 to meet pressing demands. These demands have been growing with such urgency that it is no longer possible to ignore them, and it is therefore recommended that an appropriation of $400,000 for such surveys be requested for the fiscal year 1907-8, this sum being $50,000 in excess of the amount appropriated for 1906-7.

The demand for topographic surveys on which this request for increase in appropriation is based comes from people living in many States and Territories, who are engaged in various kinds of work that depend upon or are related to the topography and economic resources of the country. The requests are received thru representatives in Congress, thru the Secretary of the Interior, thru State geologists, commissioners of agriculture, State engineers, and other State officials, and thru the War Department on behalf of the Army of the United States. For two years past these requests for topographic surveys have so far exceeded the ability of the Survey to comply with them, because of lack of funds, that the plans approved for the fiscal year 1906-7 are more than half a million dollars short on work urgently called for.

Requests are on file for topographic mapping in 62 localities in which work is considered urgent, but for lack of available funds none of these requests can be complied with. Twenty-eight of these localities are mining districts, containing precious metals, coal, oil, and iron; 5 are areas of which the Reclamation Service requested maps; 5 are areas of which maps are especially wanted for the administration of the Forest Service; 2 are areas for the proposed forest reserves in the Eastern States; 18 are areas for which there are petitions indorsed by Senators and Members of Congress, and 4 are areas for the survey of which requests have been received thru the Secretary of War on behalf of the General Staff of the Army.

Hydrography.—The amount appropriated annually by Congress since 1902 for the investigation of water resources of the United States had been $200,000 until Congress at its last session reduced the amount to $150,000 for the fiscal year 1906-7. This action will cause a corresponding reduction of work during the present year.

In adjusting the work to meet the decreased appropriation, it has been the aim to discontinue the investigations that are of the least importance in each locality rather than to make a uniform reduction thruout. The investigations relate principally to (1) occurrence and availability of ground waters, (2) measurement of stream flow, and (3) the quality of water and its application to domestic and industrial uses. In some regions large numbers of stream-measurement stations that had been established as a result of urgent demands and local needs have been discontinued; in other regions valuable ground-water investigations have been given up. In each locality the work for which there seems to be greatest economic need has been continued. While this is apparently the best solution of the difficulty, there result loss of valuable records, which by reason of their suspension will become practically useless, and retardation of the industrial growth of many localities dependent upon the development of water supplies and water power. It will be impossible for private parties or the States to undertake these investigations, for they involve in most cases interstate studies and continuous gagings for a considerable period.

Water is the most valuable of all the mineral resources of the United States. Upon no other single resource or group of resources is social and economic welfare so dependent, and to teach people how to utilize water resources is to promote their prosperity as it can be promoted perhaps in no other way. Investigations that furnish data concerning the amount, availability, and character of water, whether from ground or surface sources, should, therefore, be maintained and encouraged by the General Government.

The benefit derived from the hydrographic work in the United States is thoroly demonstrated. As an investment it has produced large returns. The results obtained under the former appropriation justify the restoration of the $50,000 at the next session of Congress. By reason of the wide extent of country involved, the lessened appropriation of $150,000 must be distributed in allotments so small that many of the investigations can not in any single year be made sufficiently thoro to permit the preparation of final reports, but with the $50,000 restored the allotment for each piece of work would be sufficient to produce results which the Survey would be warranted in publishing annually.

RECLAMATION SERVICE.

The Director of the Geological Survey acted as Director of the Reclamation Service during the year, and the chief disbursing clerk of the Survey as the chief disbursing officer of the Reclamation Service.

The more or less intimate relations that existed between the Reclamation Service and the Geological Survey from 1902 to 1905 were gradually changed, so that by June 30, 1906, connection was practically abolished, except the directorship and the disbursing. As the result of the appropriation made by Congress for additional rental for the Reclamation Service, a large proportion of its force and all of its archives were moved to another building near the Survey, and it is expected that in the early future the dissociation of the Survey and the Reclamation Service will be complete. With this in view, in the estimates it is recommended that Congress be asked to appropriate $3,000 additional rental for the Survey, and also to authorize the expenditure of $3,000 by the Reclamation Service for rental.

WORK OF THE YEAR.

FIELD AND OFFICE WORK BY THE DIRECTOR.

During the summer of 1905 the Director made a detailed study of the great series of rocks between the "Rocky Mountain front," facing the Great Plains, and Ravalli, Mont. The object of this was to work out a reference section for an extensive area of strata in northwestern Montana and northern Idaho. A detailed section of the Cambrian rocks of the House Range, Utah, was completed and large collections of fossils were made. In September the Director examined the country affected by the Strawberry irrigation project in Utah and the Gunnison tunnel or Uncompahgre project in Colorado, and late in that month he made a visit to the fuel-testing plant at St. Louis. Administrative duties pertaining to the Survey and to the Reclamation Service prevented him from doing any considerable amount of personal scientific work in the Survey, except to prepare for publication the Montana geologic section and to advance the study of the Cambrian faunas.

GEOLOGIC BRANCH.

Administration.—The geologic branch comprises four divisions, viz, the division of geology and paleontology, the division of Alaskan mineral resources, the division of mining and mineral resources, and the division of chemical and physical research. The chiefs of these four divisions formerly reported directly to the Director, but last year they were combined into a single administrative unit under the geologist in charge of geology. The purpose of this concentration of administrative authority was to secure proper cooperation and coordination in the various lines of work.

State cooperation.—Three States made appropriations for cooperative geologic work, viz, Maine, $1,500; Pennsylvania, $4,000, and North Carolina, $1,000.

Publications.—The official publications of the geologic branch during the year included 13 geologic folios, 1 monograph and the atlas accompanying another (XXXII), 12 professional papers, 16 bulletins, and the annual volume on mineral resources. These embody the economic results of the work and the principal contributions to science resulting from the various investigations. In addition there were published, with the permission of the Director, in scientific journals and the transactions of scientific societies, a large number of papers based in whole or in part on the work of this branch.

DIVISION OF GEOLOGY AND PALEONTOLOGY.

Organization.—As during the last several years, the administrative control of the division was in the hands of the geologist in charge of geology, while scientific supervision was exercised by the section chiefs. The latter are responsible for the methods employed in the various lines of investigation and for the quality of the results presented in Survey publications. The form of organization, altho somewhat complex, is thoroly satisfactory, and is necessitated by the diversity and complexity of the problems under investigation.

Personnel.—The scientific force of the division at the beginning of the fiscal year consisted of 47 geologists, 6 paleontologists, 40 assistant geologists, and 16 geologic aids. Of these, 31 geologists, 15 assistant geologists, and 10 aids were occupied continuously thruout the year; the remainder, being on the per diem roll, gave only a portion of their time or none at all to Survey work. During the year resignations and appointments resulted in a net gain of 4 in the force. In addition to the above regular force 5 field assistants were employed for a portion of the year.

GEOLOGIC WORK IN NEW ENGLAND AND NORTHERN APPALACHIAN REGION.

During the year cooperative work in Maine was continued. The mapping of the Rockland quadrangle was finished and the geologic folio prepared, and work on the Mount Desert area was continued. The text for the Penobscot Bay folio, previously surveyed, was completed and submitted for publication. Brief reports on the limestone and clay of the Rockland area and on new occurrences of slate and graphite in the State were prepared for the annual economic bulletin. A special examination of the granite quarries was made, and the detailed report, which will be issued as a bulletin of the Survey, is nearly ready for publication.

The maps and manuscripts for the Quinsigamond and Ware folios, covering several quadrangles in Massachusetts, were completed with the exception of the Pleistocene geology, on which considerable progress was made, the mapping of the Quaternary deposits of the Brookfield quadrangle being finished. Considerable progress was also made in the study of the Pleistocene geology of the areas covered by the Housatonic and adjacent folios in Massachusetts.

A special investigation was made of the several drift sheets and Pleistocene formations of Rhode Island and the southern part of Massachusetts for the purpose of differentiating them and correlating them with the pre-Wisconsin deposits of Long Island. In connection with this investigation a study was made of the clays of Cape Cod, a brief report of which was prepared for the annual economic bulletin.

In cooperation with the New Jersey State Survey the Franklin Furnace folio was completed. In connection with this work a general study of the iron-ore deposits of the pre-Cambrian region of New Jersey and southeastern New York was made for the purpose of determining the mode of origin of these ores, the study having a direct bearing on the investigation of the zinc and manganese-bearing ores in the Franklin Furnace area. As a result of this investigation a special report on the zinc-ore deposits of the Franklin Furnace and Stirling Hill regions is in preparation. It will contain a chapter on the interesting minerals of this portion of New Jersey, which has long been classical collecting ground for the mineralogist.

The mapping of the crystalline rocks of the Raritan and Passaic quadrangles and of portions of the Greenwood Lake and Easton quadrangles of New Jersey was also completed.

Special attention was given to the critical examination of type localities of crystalline rocks in New England, the New Jersey Highlands, and the Pennsylvania Piedmont Plateau region, with a view to clarifying the relations of the various crystalline rocks, a problem which is directly connected with the economic resources of the East.

Additional field work was done in the Mercersburg and Chambersburg quadrangles, in Pennsylvania, with a view to mapping the Ordovician formations on a partially paleontologic basis, and in the West Chester, Norristown, and Philadelphia quadrangles, for the purpose of elucidating certain complicated structural problems. Considerable progress was also made in the areal and economic surveys of the Coatesville and Phoenixville quadrangles, Pennsylvania, but additional field work will be necessary before the results can be prepared for publication.

GEOLOGIC WORK IN ATLANTIC COASTAL PLAIN.

In cooperation with the Maryland State Survey, stratigraphic and paleontologic studies were made in Delaware, Maryland, Virginia, and North Carolina for the purpose of correlating the Coastal Plain formations of New Jersey with those of North Carolina. The economic deposits and water-bearing horizons were studied at the same time.

As a result of cooperation with the division of hydrology in the investigation of the position and availability of the water-bearing beds of the region, considerable additions were made to the knowledge of the stratigraphy and structure of portions of the Coastal Plain in North Carolina and much valuable paleontologic material was obtained.

GEOLOGIC WORK IN EASTERN APPALACHIAN AND PIEDMONT REGIONS.

The survey of the West Virginia and Pennsylvania portions of the Pawpaw and Hancock quadrangles was completed and the Quaternary gravels of the Flintstone and Frostburg quadrangles in Maryland were mapped in detail.

Special studies were made of the cement resources of Virginia and Alabama, of the Oriskany iron ores of Virginia, and of the brown ores of southwestern Virginia. Brief reports of the results of these investigations were prepared for the annual economic bulletin, and a detailed report on the iron-ore investigations is in preparation.

The field work connected with the investigation of the granites and granite industry of Maryland, Virginia, North Carolina, South Carolina, and Alabama was nearly completed, and considerable progress was made in the laboratory study of the rocks.

In cooperation with the State Geological Survey of Virginia, a special study was made of the copper resources of the Appalachian region from Virginia southward into Alabama. A brief report on this investigation was published in the annual economic bulletin of the Survey and a full report has been prepared for publication as a special bulletin of the Virginia State Survey.

The areal and economic surveys of the Roan Mountain quadrangle in North Carolina and Tennessee, of the Morganton quadrangle in North Carolina, and of the Ellijay quadrangle in Georgia were completed. The text for the Roan Mountain folio and the geologic map for the Ellijay folio were finished and considerable progress was made in the preparation of the text for the Morganton folio.

The areal geology of the Dahlonega mining district was mapped in detail and considerable progress made in the preparation of a special economic report, but additional field work will be necessary before this report can be completed.

The investigation of the economic resources of the Balsam Mountain region in North Carolina, which was undertaken in cooperation with the North Carolina State Survey, was completed and good progress made in the preparation of the report, which will be published as a bulletin of the Survey and will include a chapter on the copper deposits of the neighboring Cowee quadrangle.

In addition, a special report, to be published as a bulletin of the Survey, on the gold belt of South Carolina was completed and submitted for publication.

GEOLOGIC WORK IN WESTERN APPALACHIAN REGION.

During the year detailed areal and economic surveys of the Punxsutawney, New Castle, and Claysville quadrangles in Pennsylvania, of the Kenova quadrangle in West Virginia and Kentucky, and of the Nicholas quadrangle in West Virginia were completed, and surveys of the Sewickley and Clarion quadrangles in Pennsylvania were started. The study of the physiography and Quaternary geology of the Catatonk quadrangle in New York was completed, and the Watkins Glen-Catatonk folio is nearly ready for publication. The manuscripts for the Amity, Rogersville, and Barnesboro-Patton (Pennsylvania) geologic folios and for the following economic bulletins were also completed and submitted for publication: On the oil and gas sands of the Claysville, Burgettstown, and Steubenville quadrangles, Pennsylvania; on the oil and gas of Greene County, Pa.; on the economic resources of the Amity, Pa., quadrangle; on the economic resources of the Kenova quadrangle in Ohio, West Virginia, and Kentucky, and on the Berea grit sandstone of the Steubenville quadrangle in Ohio. Other economic bulletins are in preparation, as follows: On the Pittsburg coal of the Claysville, Burgettstown, and Steubenville quadrangles in Pennsylvania; on the economic resources of the Nicholas, W. Va., quadrangle, and on the coal resources of the Barnesboro-Patton region in Pennsylvania. The work in Pennsylvania was done in cooperation with the State.

In addition, the following brief reports on economic investigations in this region were prepared for the annual economic bulletin, No. 285:

Coal resources of the Kenova quadrangle (Kentucky-Ohio-West Virginia).
The Clearfield coal field, Pennsylvania.
The Punxsutawney and Glen Campbell coal fields of Indiana and Jefferson counties, Pa.
The Nineveh and Gordon oil sands in western Greene County, Pa.
Notes on clays and shales in central Pennsylvania.
Clay resources of northeastern Kentucky.
Clays of western Kentucky and Tennessee.
Cement resources of the Cumberland Gap district, in Virginia and Tennessee.
Glass-sand industry in eastern West Virginia.
Iron ores of Bath County, Ky.

GEOLOGIC WORK IN GULF REGION.

During the year the study of the red hematite or fossil ores of northern Alabama was completed, and a brief report on the same was prepared for the annual economic bulletin. A large amount of work was also done in the study of the iron ores and other economic resources of the Birmingham district, and in the independent study of the newly discovered gray ore districts in the vicinity of Talladega, Ala. A series of detailed reports on these investigations is now in preparation. A brief report on the Warrior coal basin, in the Birmingham quadrangle, was prepared for the annual economic bulletin.

Progress was made in the areal and economic survey of the Brookwood and Birmingham quadrangles, Alabama, but additional field work will be necessary before the reports can be completed.

The resurvey, based on paleontologic evidence that made possible a more accurate classification and correlation of the coal-bearing formations, which had heretofore yielded meager faunas, of the southern parts of the McAlester, Tuskahoma, and Windingstair quadrangles, in Indian Territory, was completed. Brief investigations were also made of the oil and gas prospects in the vicinity of Huntsville, Ala., and of the copper deposits of Archer County, Tex.

GEOLOGIC WORK IN GREAT LAKES REGION.

During the year the detailed areal survey of the Hartford, West Bend, and Poynette quadrangles, in southeastern Wisconsin, made with special reference to the Quaternary geology, was completed, and that of the Baraboo quadrangle was commenced. The manuscript for the Milwaukee Special folio was completed. The revision of the manuscript for a professional paper on the bowlder trains of south-central Wisconsin and their relations to the glacial formations of the region was completed, but additional critical field studies will be made—it is expected during the present field season—before the manuscript is transmitted to the printer.

The glacial formations, ancient lake deposits, soils, surficial and underground waters, and physiographic features of the eastern portion of the upper peninsula of Michigan were studied in the field and mapped, the results being incorporated in a report which will be published as a monograph. In connection with this study considerable additional information was obtained regarding the former extent of the Great Lakes in this region. Additional studies were also made of the lacustrine features of the territory covered by the proposed monograph on the Michigan glacial lobe, but considerable additional work will be necessary to complete this report. In connection with these surveys in Michigan cooperation was carried on with the division of hydrography in an investigation of the underground waters of the State, the results of which will be published in the series of water-supply papers.

GEOLOGIC WORK IN MISSISSIPPI VALLEY.

During the year the areal and economic survey of the Eureka Springs quadrangle, in Arkansas, was completed and considerable progress made in the preparation of the folio. The manuscript for the Winslow folio, previously surveyed, was also completed and submitted for publication.

Progress was made in the general study of the lead and zinc deposits of the Mississippi Valley. A detailed report on the deposits of the upper Mississippi Valley was prepared and submitted for publication, and other reports are in preparation. In connection with this study special paleontologic investigations were made for the purpose of elucidating stratigraphic problems which have a direct bearing upon the distribution of these metals.

A detailed paleobotanical microscopic examination was made of samples of the oil shales which are associated with the lead and zinc deposits of southwestern Wisconsin, for the purpose of determining the causes of the localization of the hydrocarbons that seem to have influenced the distribution of the ores. As this investigation seems likely to offer a satisfactory explanation of the origin of the oil and gas in the older Paleozoic rocks, plans have been made to continue it and extend it to some of the areas of Ordovician and Silurian oil and gas.

In April a general reconnaissance of the Carboniferous coal field of Arkansas was undertaken and is still in progress.

Brief reports on the glass sand of the middle Mississippi basin and on the clays of Garland County, Ark., were prepared for the annual economic bulletin.

GEOLOGIC WORK IN ROCKY MOUNTAIN AND PACIFIC STATES.

In the Rocky Mountain and Pacific States—a region that presents complex geologic problems and is rich in metalliferous and other economic resources—many surveys and investigations were carried on. These group themselves into the following classes: Areal and stratigraphic studies; glacial and physiographic studies; investigations of gold, silver, lead, and copper deposits; fuels; iron ores; miscellaneous economic deposits.

Areal and stratigraphic studies.—The Santa Cruz (California) geologic folio and a bulletin on the geology of the Taylorsville (Cal.) region were completed and submitted for publication The mapping of the Corona quadrangle, in southern California, was also completed.

The Corona is the first of a series of quadrangles, comprising the Hesperia, Deep Creek, San Bernardino, Redlands, and one (unnamed) which includes the south end of the Tehachapi Mountains at the point of their junction with the Coast Ranges, which have been selected for early mapping, because it is believed they will furnish the key to the general geology of this section of the State. A geologic reconnaissance from the southern borders of the San Joaquin Valley in California northward to the south line of Merced County resulted in the preparation of a report designed to be published as a bulletin of the Survey, but it is probable that the report will not be published until the additional work necessary to complete the reconnaissance of the valley north of Suisun Bay has been done.

In Colorado about half of the Lake City quadrangle was surveyed in detail, some preliminary work was done in the neighboring San Cristobal quadrangle, and a reconnaissance was made of the Uncompahgre plateau for the purpose of elucidating certain stratigraphic problems. Special studies included one on the stratigraphy of the Cretaceous rocks of the Routt County coal field and another on the Morrison formation and overlying strata near Canyon, the latter being a continuation of a study of the same beds in New Mexico and southern Colorado which was made earlier in the season.

In connection with the completion of the detailed survey of the Cœur d'Alene mining district, which was begun the preceding field season, a stratigraphic reconnaissance was made in northern Idaho and northwestern Montana, the general results of which are incorporated in the economic report on the Cœur d'Alene district, which is nearly ready for publication.

Progress was made in the study of the marine Tertiary fauna of the Pacific coast, which has been of fundamental importance in determining the petroleum horizons of that region. As a result of the field work in this connection several geologic reconnaissance maps were prepared of areas studied, chiefly within the counties of Fresno, Kern, King, and San Luis Obispo, in California.

Glacial and physiographic studies.—Special glacial and physiographic work in this region included the completion of the report on the glaciation of the Uinta Mountains, Utah, which was submitted for publication, and the preparation of a bulletin on the landslides and rock streams of the San Juan region, Colorado, which is nearly ready for publication. Considerable progress was also made in the determination of the maximum glaciation of the Sierra Nevada, a problem of great scientific interest; but much additional field work will be necessary before a satisfactory report can be prepared.

Investigations of gold, silver, lead, and copper deposits.—The revival of mining activity in Nevada and the recent development of several new and important districts in the southwestern part of the State have created a great demand for information concerning the geology of this region. This has been met by a geologic reconnaissance of about 8,500 square miles of southwestern Nevada and eastern California. The area surveyed has been designated the Amargosa region, and includes the Goldfield, Bullfrog, Tokop, Silverbow, Kawich, Lida, and other mining districts, as well as a large part of Death Valley. A general report on the geology of this region has been practically completed. The Goldfield and Bullfrog districts were mapped and studied in detail, and complete geologic reports are in preparation. A preliminary outline of these investigations, with notes on the Manhattan, Searchlight, Eldorado, and other mining districts in the southwestern part of the State, is now ready for publication.

Other investigations of the precious metals, lead, and copper of the West include a report on the ore deposits, chiefly gold, of the Silver Peak quadrangle, Nevada, which was completed and is now in the hands of the Public Printer; a detailed report on the geology and ore deposits, principally lead and silver, of the Cœur d'Alene mining district, in Idaho, which was carried nearly to completion; a detailed report on the copper deposits of the Butte, Mont., district, which is nearly completed and will be submitted for publication before the close of the present calendar year; a detailed report on the Park City mining district, Utah, including a reconnaissance report on the neighboring Cottonwood mining region, which was carried nearly to completion and will be finished before the end of the year; a brief study of the copper deposits of the Sierra Nacimiento and the neighboring Zuni Mountains, the results of which have been embodied in brief reports that will appear as chapters in the general report on the mineral deposits of New Mexico; a short study of the placer gold deposits near Hahns Peak, Colorado, which resulted in the preparation of a contour map, covering about 25 square miles, and a brief report, published in the annual economic bulletin; and the completion of the special geologic map of the "Downtown district" of the Leadville region, Colorado.

In addition to the foregoing the annual economic bulletin contains a number of short papers on the precious metal and copper resources of other localities in the Western States.

A special study was also made to determine the horizon of the supposed Jurassic rocks of the northern Sierra Nevada, in which are contained the extensive metalliferous deposits of that region. This investigation, however, was not completed, and another season of field work will be necessary before the results can be prepared for publication.

Fuels.—In response to the demand for information regarding the fuel resources of the country a number of reconnaissance surveys were made of the coal fields of the West, notably the following: An area of approximately 2,250 square miles in southwestern Wyoming, surveyed with special reference to coal and oil; an area of about 1,200 square miles, comprizing the coal lands in the valley of Yampa River, in Routt County, Colo.; the lignite coal fields of southwestern North Dakota, northwestern South Dakota, and eastern Montana; the Durango-Gallup coal field, in the northwestern part of New Mexico and the adjacent part of Colorado. Brief reports on all of these surveys were prepared for the annual economic bulletin, and detailed reports have been completed and submitted for publication.

In cooperation with the General Land Office an investigation of certain contested coal lands in Utah was undertaken, with a view to the classification of the lands according to their mineral or nonmineral character. During the season surveys were made of the Book Cliffs coal field and of the coal lands in the vicinity of Coalville and Provo. Brief reports were prepared for the annual economic bulletin, and detailed reports were completed and submitted to the General Land Office. During the last four months of the fiscal year the Survey cooperated with the Department of Justice in the investigation of coal-land frauds in Utah and Colorado. These investigations are still in progress.

A detailed report on the three southernmost oil fields of California was completed and submitted for publication, and a brief report on the recently developed Salt Lake oil fields near Los Angeles was prepared for the annual economic bulletin. In addition, the annual economic bulletin contained the following reports on the fuel resources of the West: The Engle coal field of New Mexico; the coal of the Mount Diablo Range, Monterey County, Cal.; the mineral resources, chiefly coal and lignite, of the Bighorn Mountains and the Bighorn Basin, Wyoming.

Iron ores.—In pursuance of the systematic investigation of the iron ores and iron industry of the United States the following investigations were made during the year in the Rocky Mountain and Pacific Coast States: A reconnaissance of the iron ores of central Colorado, including deposits near Ashcroft and White Pine in the Sawatch Range, those in the Cebolla district south of Gunnison, and in the pre-Cambrian rocks in the vicinity of Salida; the detailed mapping of the deposits of Iron County in southern Utah and a study of the genesis of the ores; an examination of the deposits near Daggett, in San Bernardino County, Cal.; an examination of the deposits in the Seminole Mountains, northwest of Rawlins, Wyo.; laboratory studies of the western iron ores. A brief paper on the iron ores of the western United States and British Columbia was also prepared for the annual economic bulletin.

Miscellaneous economic investigations.—The special investigation of the relation of hydraulic mining and natural stream erosion in the

Sierra Nevada to agriculture, grazing, and other industries in the Sacramento Valley, which is being made in response to a memorial to the President and in cooperation with the division of hydrography, was well advanced, but owing to the intricacy of the problem and the many and conflicting interests at stake additional field and laboratory work will be necessary before the results can be prepared for publication. In connection with this investigation a laboratory has been equipped at Berkeley for the purpose of studying the natural laws which control the transportation of débris by streams, the necessary space, power, and other facilities for the experiments being contributed by the State University of California.

Other economic investigations in the West included the following: A reconnaissance of the mineral deposits of New Mexico, a special report on which was completed and submitted for publication; an examination of the asphalt lands near Thistle Junction, Utah, and of the ozokerite deposits near Colton and Soldiers Summit in the same State, brief reports on which were prepared for the annual economic bulletin, the detailed reports being submitted to the General Land Office.

The following additional brief reports were prepared for the annual economic bulletin: A Nevada zinc deposit; Cement resources of Washington; Some magnesite deposits of California; Gypsum deposits of the Uncompahgre region, Colorado; Gypsum deposits and bentonite of the Laramie Basin, Wyoming; Volcanic ash near Durango, Colo.

GENERAL SCIENTIFIC INVESTIGATIONS.

Geologic map of the United States.—In order to meet the demand for revised geologic maps of the United States and of the several States which shall represent the present condition of knowledge, a map of the United States on the scale of 1:2,500,000 was undertaken and considerable progress made in its preparation, also in the assembling of data for the preparation of geologic maps of the States, or of groups of States, on the scale of 1:1,000,000. The United States map awaits the completion of the base, on which as rapid progress as possible is being made, and the data for the State maps, which will necessarily be more detailed, are being rapidly collated.

Special geologic map of North America.—In cooperation with the Governments of Canada and Mexico, a geologic map of North America on the scale of 1:5,000,000 is in preparation by the Geological Survey. A preliminary edition of this map will be issued at the expense of the International Geological Congress to be held in the City of Mexico in September, 1906, and an edition will later accompany a professional paper.

Earthquakes.—The record catalog of earthquakes occurring in the United States has been continued. It contains information obtained thru newspapers, thru reports of the Weather Bureau, thru the Light-House Board, and by special correspondence. The severe earthquake which occurred in California on the morning of April 18 was made the subject of a special investigation, in which the Geological Survey cooperated with the State of California and the Carnegie Institution. Two officers of the Geological Survey became members of the commission appointed by Governor Pardee, of California, and a third was temporarily detailed to assist in the work. This commission is studying the phenomena of the earthquake in a systematic manner, and has already made a preliminary report. The Geological Survey has also investigated the injury to buildings and other structures in San Francisco and vicinity, for the purpose of ascertaining what materials and forms of construction are best adapted to withstand earthquake vibrations.

PALEONTOLOGIC WORK.

In addition to the usual routine work of the paleontologists—that of aiding, by the identification of contained fossils, in the determination of questions of age and stratigraphy—which is performed for members of the Survey and the various State surveys, many special paleontologic investigations were carried on during the year.

Tertiary and Quaternary.—The study of the marine Tertiary fauna of the Pacific coast, which has been of fundamental importance in determining the oil and petroleum horizons of that region, was considerably advanced during the year, especially by the large collections of fossils obtained in Fresno, King, Kern, and San Luis Obispo counties, Cal. Satisfactory progress was made in the preparation of a monograph on this fauna, and in connection with it a bibliography and reference card catalog of the several thousand Tertiary and Quaternary species of the coast was prepared in order to facilitate the identification and study of fossils from those horizons.

The knowledge of Tertiary faunas was especially augmented by a large collection of Pliocene and Pleistocene fossils from Port Limon, Costa Rica, which have an important bearing upon the relations of the Tertiary of California to that of the Gulf of Mexico.

The monograph on the Tertiary corals of North America was also well advanced, and considerable progress was made in the preparation of a report on the Miocene of the Coos Bay region of Oregon.

The study of large collections of fossils from Georgia, gathered in connection with the investigation of underground waters, resulted in mapping the Tertiary formations of a large part of southeastern Georgia of which previously little or nothing was known, while an interesting collection from the Oligocene of Florida threw much light on the Tertiary of that region.

Cretaceous.—Considerable progress was made in the study and description of the Lower Cretaceous fauna of Texas, a work which has been in preparation for several years, such time as could be spared from immediately pressing duties being devoted to it.

Triassic.—Satisfactory progress was made in the preparation of the monograph on the Triassic cephalopods of America. A large quantity of valuable material was collected from the Upper Trias of Shasta County, Cal., and that previously collected from the Triassic of Nevada, Idaho, and California was classified and studied in detail. The work in Shasta County resulted in clarifying certain stratigraphic problems of that region which have a direct bearing upon the study of the economic resources.

Carboniferous.—The manuscript for a professional paper on the unique Guadalupian fauna of Texas, which is widely different from the typical Pennsylvanian, from the Permian of the Mississippi Valley, and from the Russian Permian, altho bearing some resemblances to the latter, was completed and submitted for publication, and the manuscript for a professional paper on the Lower Carboniferous ore-bearing beds of Missouri was partly written. The latter study was made in order to facilitate the correlation of the different ore-bearing horizons of the Missisippian series with one another and with the standard section of the Mississippi Valley in Missouri and Iowa.

The Devono-Carboniferous series of Pennsylvania was made the subject of a special geologic and paleontologic study, but additional field work will be necessary before the results can be prepared for publication.

Devonian and Silurian.—The Devonian and Silurian stratigraphy and faunas were the subject of an investigation with reference to the modifications which they exhibit in passing north and northwest from central Kentucky to Wisconsin, a question which has an important bearing on the distribution of the lead and zinc deposits of that region.

Cambrian.—A monograph on the Cambrian brachiopods was brought very nearly to completion and will be submitted for publication early in the next year. Field investigations in the extensively developed Cambrian formations of western Montana and central Utah were continued.

General.—Special paleontologic field studies were made in southeastern Alaska for the purpose of determining the limits of the principal geologic horizons and the order of succession. A bulletin on the paleontology of the Santa Cruz region in California, based on material gathered in connection with the areal and economic survey of that quadrangle, was well advanced. The monograph on the Ceratopsia was completed and is now in the hands of the printer, and considerable progress was made on the Sauropoda and Titanothere monographs, but owing to the magnitude and difficulty of the tasks additional work remains to be done. This study is being greatly facilitated by the notes and collections incidentally made by geologists engaged in other investigations. Special collections of fossils were made in the vicinity of Murfreesboro, N. C., for the purpose of recovering species obtained in that locality by Wagner about 1832 and hitherto not represented in the Survey collections.

PALEOBOTANIC WORK.

A monograph on the fossil flora of the Laramie, the great coal-bearing formation of the West, was well advanced, and will probably be finished next year. This monograph is one of the results of a special investigation made for the purpose of affording an easy means of identifying this formation and aiding in the classification of the coals of the different localities.

In connection with the mapping of the areal geology of the Kenova quadrangle, in Kentucky, Ohio, and West Virginia, a special study was made of the paleobotany of the Upper Carboniferous formations of that region for the purpose of ascertaining the extent of the basal unconformity and to aid in correlating the succeeding Coal Measures groups with the rocks in Pennsylvania. A similar study was made in the Birmingham, Ala., quadrangle, which it is hoped will establish the correlation of the enormously thickened coal-bearing section of that State with the formation recognized in the basins farther north in the Appalachian trough and permit the identification of the equivalents of the minor subdivisions or coal groups in the several detached basins.

At the request of the chief of the Brazilian coal commission several collections of fossil plants from the coal fields of Santa Catharina and Rio Grande do Sul were examined and reported upon by Survey paleobotanists, and on the completion of the work the material, which is of considerable scientific value, was presented to the United States National Museum by the Brazilian commission.

Satisfactory progress was made in the work on the bibliography and compendium of paleobotany, which not only serves as a working guide for Survey paleobotanists but is consulted by American paleobotanists generally, and frequently by those of other countries.

PETROGRAPHIC LABORATORY.

The petrographic laboratory, in which three persons were employed continuously and one temporarily, remained in charge of the chief of the section of petrology. Its high record of efficiency was maintained thruout the year, the total output being as follows: Thin sections of average size, 6,295; large or difficult sections, 257; saw cuts, 1,134; surfaces polished, 85. The petrographic reference collection also remained in charge of the chief of the section of petrology, and was substantially increased during the year.

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under the appropriation of $80,000 made for "a continuation of the investigations of the mineral resources of Alaska." Under this authority the following classes of work were done: Reconnaissance and detailed geologic surveys; special investigations of mineral deposits; reconnaissance and detailed topographic surveys.

SEASON OF 1905.

The permanent technical field personnel of the division embraced 11 geologists on annual salaries, 1 geologist on a per diem salary, and 4 topographers. One paleontologist gave a part of his time to the Alaskan work. The office work included 1 geologist, 1 clerk, and 1 typewriter on annual salaries, and 1 typewriter holding a temporary appointment. In addition to the regular technical force, 4 geologic and 4 topographic assistants and 1 special assistant, together with 28 packers, cooks, etc., were employed in Alaska during the summer of 1905.

Nine parties were engaged in field work during the open season, from about May 15 to October 15, in 1905. Several of these were subdivided after reaching Alaska, making 14 parties in all.

Southeastern Alaska.—A party of 2 geologists, a part of the time assisted by a paleontologist, continued the reconnaissance work in the Panhandle. The preliminary study of the geology and mineral resources of the Ketchikan and Wrangell districts was completed. An outline of the results has been published in Bulletin No. 284 and a more complete statement is in preparation.

Yakutat Bay.—Three geologists were engaged in this field from June until September. A geologic reconnaissance was completed and a preliminary statement of results has been published in Bulletin No. 284. In connection with the survey of the gold-bearing beach gravels and the lignite deposits, a special study was made of the glaciers of this region, of the evidence of former glaciation, and of the remarkable deformation of the earth's crust which occurred during the earthquake shock of September, 1899. A detailed report on these investigations is in preparation.

Controller Bay.—Two geologists and 2 topographers were employed in detailed surveys in this field from May until October. Topographic surveys of 430 square miles, lying between 60° and 60° 30′ north latitude and 139° 45′ and 144° 35′ west longitude, were completed for publication on a scale of 1:62,500, with 50-foot contours. Of levels, 97½ miles were run and 9 permanent bench marks were set. Of traverse, 183 miles were run. Reconnaissance topographic surveys (1:250,000) were also carried over about 200 square miles of additional area. The geologists made surveys of about the same area as the topographers, and made a special study of the coal fields of the region. An outline of the important results is contained in Bulletin No. 284.

Prince William Sound.—Two geologists were engaged from June 25 to September 15 in making a reconnaissance of the shores of Prince William Sound. All the known copper deposits were examined in detail. A preliminary statement of results has been published (Bulletin No. 284) and the final report is in preparation.

Matanuska Valley.—The coal fields of this district were hastily examined by a geologist during the month of August, and a statement of the results is in press (Bulletin No. 289).

Herendeen Bay.—A rapid reconnaissance of the coal-bearing rocks of this region was made by a geologist in June, 1905, and the results have been published in Bulletin No. 284.

Seward Peninsula.—Three topographers, working from June to October, 1905, completed the survey of the areas of the Solomon Special and the Casadepaga Special maps, embraced between longitude 164° and 164° 30′ and latitude 64° 30′ and 65°, and including 470 square miles. The scale was 1:62,500, with 25-foot contours. Levels to the extent of 93.9 miles were run and 17 permanent bench marks were established.

Detailed studies of an area of about 300 square miles in the Nome region were made by two geologists during the summer of 1905. In addition to this the same men made a further study of the tin deposits at York and of the gold placers of the Solomon River and Ophir Creek regions. The results of the latter work are contained in Bulletin No. 284.

Yukon-Tanana region.—Topographic reconnaissance surveys (1:250,000, contours 200 feet) were extended over an area of 4,300 square miles by two topographic parties. The mapped area includes a part of the Birch Creek, Beaver Creek, and Tolovana River basins. The work was controlled by triangulation carried westward from points previously established in the Birch Creek basin. A part of the area covered by these surveys is included in the Circle quadrangle, in the Yukon-Tanana region, a report on which is in press (Bulletin No. 295). A geologist accompanied the topographic party, working in the Beaver Creek region, and made an areal reconnaissance of the area traversed, and the results have been published in Bulletin No. 284. The field season was cut short by the early snow which fell on September 4.

A party of two geologists carried a reconnaissance westward from the international boundary at the head of Sixtymile Creek to the mouth of Delta River and thence to Fairbanks. A part of the results of this work is in print (Bulletin No. 284).

General.—The geologist in charge has been chiefly occupied in routine administrative work. In July, 1905, he visited the parties working in southeastern Alaska and in the Controller Bay region. Considerable time was also spent on a report entitled "The gold placers of Seward Peninsula," which is now nearly completed.

SEASON OF 1906.

Under a continuation of the same appropriation 12 parties were dispatched to Alaska during the months of May and June, 1906. Of these, one topographic and one geologic party were sent to southeastern Alaska. A geologic party went to the St. Elias region and one to complete the mapping of the Controller Bay region. The region lying adjacent to the upper end of Cook Inlet is to be surveyed by two parties. A geologic party is to continue detailed work in the Nome region. By cooperation with the division of hydrography stream gaging was begun in the Nome region. Two topographic parties are continuing reconnaissance surveys in the Yukon-Tanana region. One geologic party has been dispatched to the newly discovered Kantishna placer district and another has been directed to work along the upper Yukon.

DIVISION OF MINING AND MINERAL RESOURCES.

During the year ending June 30, 1906, the division was engaged in the preparation of the reports on the mineral resources of the United States for 1904 and 1905. The report for 1904 was completed and published, and the report for 1905 is approaching completion. Manuscripts for most of the chapters are in hand, and some of them have already been published as advance extracts. The reports received indicate that the total value of the mineral products of the country in 1905 may exceed the value in 1904 by 10 per cent.

The work on the black sands of the Pacific coast, which was authorized by Congress and organized before the fiscal year began, was pushed vigorously during the year at Portland, Oreg., where exceptional facilities for this work were offered by the Lewis and Clark Exposition. The results have exceeded all expectation, and the investigation bids fair to lead to the development of an important and lucrative industry in the utilization of the black sands of the country as a source of gold, platinum, iron ore, and some of the rare metals. It is highly important that this work be continued on the Pacific coast and that it be extended to the promising fields along the Atlantic seaboard.

A considerable portion of the time of this division is consumed in answering technical inquiries, and laboratory facilities should be afforded the division for making simple tests for determining the mineralogic character of the large number of specimens submitted to it annually. It is not intended that the work of this division should take the place of the commercial chemist, but merely that it be placed in a position to advise correspondents of the nature of specimens submitted and whether or not the material is worth further investigation.

The chief of the division has been designated by the Secretary of the Interior to cooperate with the Jamestown Exposition Company in the organization of a mining exhibit at the exposition, to be held in 1907.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

During the year 144 analyses were reported from the laboratory, together with 567 determinations of minerals received from various sources. This, with the usual amount of administrative detail, correspondence, etc., represents the routine work of the laboratory.

Apart from the routine, the scientific work of the division has been as follows:

Progress was made on a monograph of geochemistry, and the first draft of the manuscript is approaching completion. Much work was done on analytical methods, especially with reference to the determination of the moisture in coals, of fluorine, ferric iron, and manganese in rocks, and a revision of Bulletin No. 176 is nearly completed. A considerable number of rare minerals was examined, especially a series of unusual ores of mercury from Texas. Progress was made upon a research into the secondary enrichment of ores. An investigation was made upon the determination of manganese and zirconia in rocks. A large amount of work was done upon crystallographic measurements, especially of the mercury minerals referred to above. Studies were also made upon the minerals of the lithia region of California.

In the physical laboratory, after completion of the memoir on "The isomorphism and thermal properties of the feldspars," two other series of minerals were taken up, in order, if possible, to carry thru an equally careful investigation of some typical eutectic series. The minerals chosen for these studies were the magnesium silicates and the lime silicates. A paper on "Wollastonite and pseudowollastonite, polymorphic forms of calcium metasilicate," was completed and published, and a paper on a very interesting and complicated tetramorphic relation occurring in the magnesium silicate series is now nearly ready for publication. As a part of the same general plan of investigation, another investigator was engaged upon the limestone series, studying all possible stable forms from pure lime to pure silica. A careful investigation was also made of the phenomena attending the melting of pure silica (quartz); this has immense technical interest on account of the value of quartz glass, which can be heated white hot without softening and while still hot be plunged into water without breaking.

The more interesting facts developed in the experiments upon quartz were published in Science during the year. A paper on the calcium silicates is nearly ready for the printer, and considerable progress can be reported upon a fundamental investigation of the scale of temperatures in terms of which all the work of the laboratory is exprest. The existing German scale extends only to 1,150° C., which is insufficient for effective work with the minerals. A gas thermometer was therefore constructed, and after several months of preliminary work it is possible to say that greater accuracy as well as greater range has been attained.

Members of the division have been engaged, also, in the study of finite elastic strains, as an incident to which a useful series of mathematical tables was prepared.

TOPOGRAPHIC BRANCH.

The organization of the topographic branch remained the same as it had been during the two immediately preceding years.

COOPERATION BY STATES.

Cooperative arrangements for topographic surveys were made with fourteen States. The governor of the State of Illinois allotted $10,000; the legislature of California appropriated $15,000; the director of the Kentucky Geological Survey allotted $5,000; the State Survey Commission of Maine, $3,200; the State geologist of Maryland, $2,500; the State geologist of Michigan, $2,000; the State engineer and surveyor of New York, $600; the commissioner of agriculture of North Carolina, $4,000; the governor of the Territory of Oklahoma, $5,000; the governor of Ohio, $23,800; the governor of Oregon, $2,500; the State Survey Commission of Pennsylvania, $14,000; the State geologist of West Virginia, $15,000; and $400 was allotted by the forestry commission of New Hampshire for a special sheet. Thus $103,000 was allotted by the States mentioned, in addition to the Federal appropriation for topographic work

SUMMARY OF RESULTS.

The following summary includes all small-scale topographic surveys made by the divisions of topography, including those of forest reserves, and by the division of Alaskan mineral resources:

Primary azimuth observations were made at two triangulation stations. Triangulation stations to the number of 328 were occupied or located and marked, and 3,261 miles of primary traverse were run. In the course of this work 51,430 square miles were covered by primary control.

The condition of topographic surveys to June 30, 1906, distinguished as to scale, etc., is shown on a general map of the United States, Pl. I, and the detailed distribution of this work in the various States and Territories is shown on the accompanying maps, Pls. II–XXIII. On the latter are indicated by proper symbols the sheets published to June 30, 1906, the sheets in course of publication, and the areas surveyed during the field season of 1905 and drawn in map form in the office season of 1905–6. By appropriate symbols these maps also show areas in which precise or primary spirit levels have been run and unmapped areas which are controlled by primary triangulation or traverse or by astronomic positions.

As shown in the following table giving the details of topographic mapping and spirit leveling for the fiscal year, the total of new surveys was 36,605 square miles. The total area surveyed in the United States to date is 992,601 square miles, or about 32 per cent.

In addition, 3,179 square miles of revision or resurvey were completed by final topographic mapping in the eastern division and 1,016 in the western division, over which preliminary reconnaissance surveying had been previously carried, thus making the total area of actual surveys for the season 40,800 square miles.

In connection with these surveys there were run 38,307 linear miles of spirit levels, of which 892 miles were precise, making the spirit leveling done since the authorization of this class of work by Congress, in 1896, amount to 196,371 miles. In addition, 327 miles of forest-reserve boundary lines were run, 12 miles were retraced, and 15 miles of supplemental lines were run.

The total area covered by topographic surveys made in Alaska during the fiscal year 1905–6, as reported in detail on pages 25–26, was about 5,300 square miles, in the course of the mapping of which 191 miles of spirit levels were run and 26 permanent bench marks were established.

Present condition of topographic surveys of the United States, and new areas surveyed in 1905–6.

State or Territory.	New area surveyed in 1905–6.	Total area surveyed to April 30, 1906.	Percentage of total area of State surveyed to April 30, 1906.
	Sq. miles.	*Sq. miles.*	
Alabama		17,534	34
Arizona	775	62,375	55
Arkansas		20,469	38
California	6,441	74,976	47
Colorado	1,221	36,711	35
Connecticut		5,047	100
Delaware		1,008	49
District of Columbia		70	100
Florida		1,821	3
Georgia	1,310	16,829	28
Idaho	263	15,196	18
Illinois	1,430	6,345	11
Indian Territory		30,620	99
Indiana	131	2,442	7
Iowa	291	9,686	17
Kansas		64,159	78

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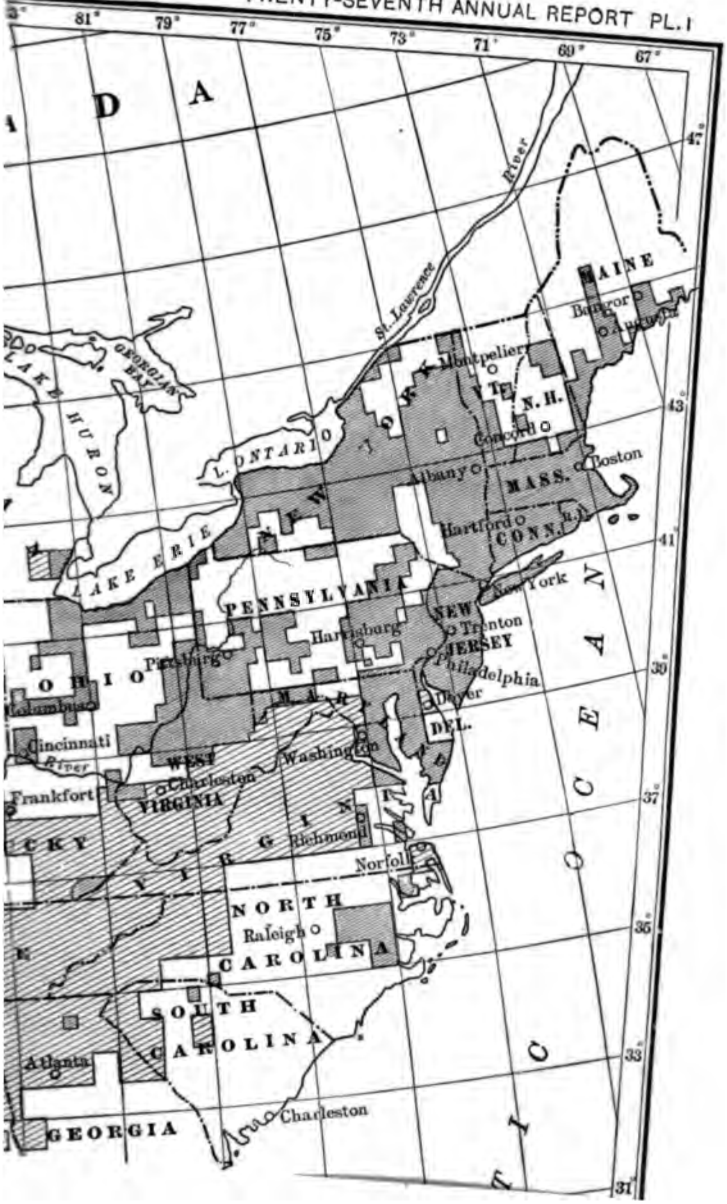


Present condition of topographic surveys of the United States, and new areas surveyed in 1905–6—Continued.

State or Territory.	New area surveyed in 1905–6.	Total area surveyed to April 30, 1906.	Percentage of total area of State surveyed to April 30, 1906.
	Sq. miles.	*Sq. miles.*	
Kentucky	547	13,791	34
Louisiana	71	7,698	16
Maine	210	6,515	20
Maryland	....	10,294	84
Massachusetts	....	8,332	100
Michigan	47	3,313	6
Minnesota	236	2,876	3
Mississippi	404	653	1
Missouri	925	33,489	47
Montana	856	44,830	31
Nebraska	200	25,974	34
Nevada	7,232	36,185	33
New Hampshire	266	3,089	33
New Jersey	....	7,756	98
New Mexico	....	28,022	23
New York	1,061	37,576	76
North Carolina	607	16,645	32
North Dakota	841	8,678	12
Ohio	3,901	16,497	40
Oklahoma	356	4,510	12
Oregon	2,255	15,296	16
Pennsylvania	1,286	18,245	40
Rhode Island	....	1,131	100
South Carolina	312	5,328	17
South Dakota	329	17,814	23
Tennessee	....	19,849	47
Texas	321	64,539	24
Utah	93	63,320	75
Vermont	....	3,463	36
Virginia	66	29,463	69
Washington	505	16,971	25
West Virginia	713	22,576	91
Wisconsin	5	10,914	19
Wyoming	1,098	21,681	22
	36,605	992,601	....

EASTERN DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic surveying was carried on by 67 parties working in 26 States, namely, Alabama, Arkansas, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Carolina, Vermont, Virginia, West Virginia, and Wisconsin. The survey of 49 new quadrangles and the resurvey or revision of 11 reconnaissance sheets were completed. In addition, 60 new quadrangles were partly surveyed and 8 were partly resurveyed. The total new area mapped was 14,863 square miles, of which 3,076 square miles were for publication on the scale of 1:125,000 and 11,787 square miles were for publication on the scale of 1:62,500. There were resurveyed or revised 1,296 square miles on the publication scale of 1:125,000 and 1,883 square miles on the publication scale of 1:62,500.

In connection with this work 33,590 linear miles of spirit levels of all grades were run, and 1,317 permanent bench marks were established along the routes run by precise and primary methods. Along the remainder, of secondary order, temporary bench marks were set at distances of about 1 mile. Primary control was carried on during the season by 6 parties working in portions of 19 States. They controlled 19,130 square miles lying within 77 quadrangles.

Topographic surveys in eastern division from May 1, 1905, to April 30, 1906.

State or Territory.	Contour interval.	Scale of publication.				Total area surveyed.	Levels.	
		1:125,000.		1:62,500.				
		New.	Resurvey or revision.	New.	Resurvey or revision.		Distance run.	Bench marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Alabama	20	....	....	....	384	384	669	51
Georgia	50	1,310	....	....	[a]81	1,391	1,780	113
Illinois	10, 20	....	....	1,430	....	1,430	3,740	101
Indiana	20	....	....	131	....	131	202	2
Iowa	20	....	....	291	....	291	587	19
Kentucky	20	....	....	[b]547	....	547	1,289	20
Louisiana	10	....	....	71	....	71	282	23
Maine	20	....	....	210	....	210	220	19
Maryland	20	....	....	....	299	299	519	63
Michigan	20	....	....	[c]47	....	47	189	24
Minnesota	20	....	....	236	....	236	592	24
Mississippi	20	....	....	404	....	404	355	21
Missouri	20, 50	925	4	3	....	932	1,369	71
Nebraska	20	....	....	200	....	200	290	18
New Hampshire	20	....	....	[d]266	....	266	394	32
New York	20	....	....	1,061	3	1,064	964	35
North Carolina	100, 20, 10	....	1,149	607	....	1,756	2,048	43
North Dakota	50	841	....	....	....	841	906	31
Ohio	10, 20	....	....	3,901	124	4,025	8,651	236
Pennsylvania	20	....	....	1,286	48	1,334	2,958	109
South Carolina	100, 20	....	143	312	....	455	1,402	27
Vermont	....	....	....	....	....	....	66	11
Virginia	50, 10	....	....	66	9	75	490	38
West Virginia	20	....	....	713	717	1,430	2,546	124
Wisconsin	20	....	....	5	218	223	704	62
Total	....	3,076	1,296	11,787	1,883	18,042	33,212	1,317

[a] One square mile of the above was mapped on Kenesaw Battlefield Special, on scale of 5 inches to 1 mile, with contour interval of 10 feet. Eighty square miles were mapped on Dahlonega Special, on publication scale of 1:36,000, with contour interval of 20 feet.

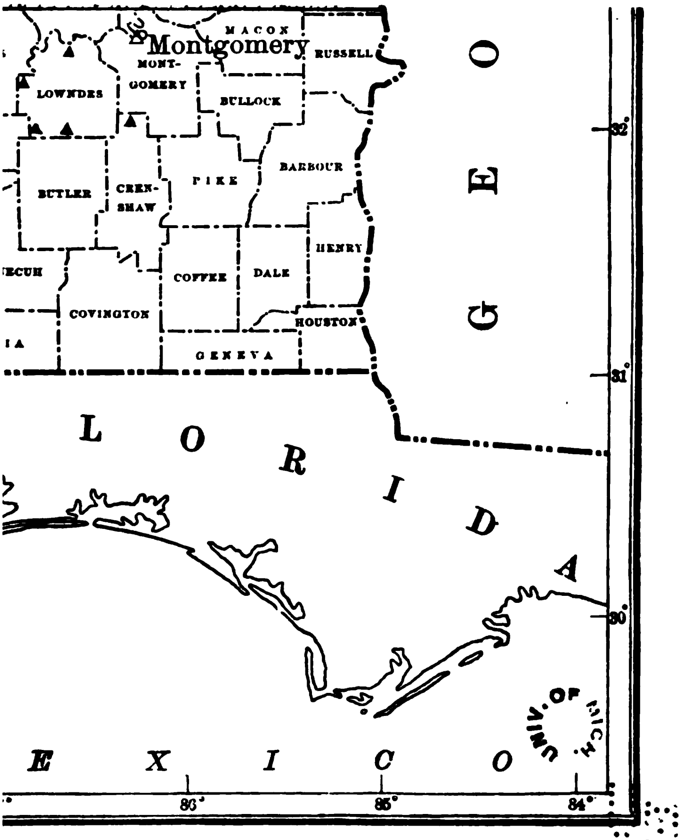
[b] Included in this area are 37 square miles, embracing suburbs of Louisville, on scale of 1:24,000.

[c] Marquette quadrangle has been mapped for publication on scale of 1:24,000.

[d] Blue Mountain Special, covering 29 square miles of this area, has been mapped on publication scale of 1:24,000.

DETAILS OF TOPOGRAPHIC FIELD WORK, BY STATES.

Alabama.—One party was engaged in field work in the State during the season. The resurvey of the Bessemer Special quadrangle, in Jefferson and Shelby counties, and of the Leeds quadrangle, in Jefferson, St. Clair, and Shelby counties, was completed. This work was on the publication scale of 1:62,500, with a contour interval of 20 feet. A partial resurvey was made of the Bessemer quadrangle, in Bibb, Chilton, Jefferson, and Shelby counties, which was originally intended for publication on the scale of 1:125,000, with a contour interval of 50 feet, but it has been decided to publish the results on four 15-minute sheets, with a scale of 1:62,500. In the course of this work 364 square miles were resurveyed, during which 669 miles of spirit levels were



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run and 51 bench marks and 4,706 elevations were established, and 2,095 linear miles of road traverse were run.

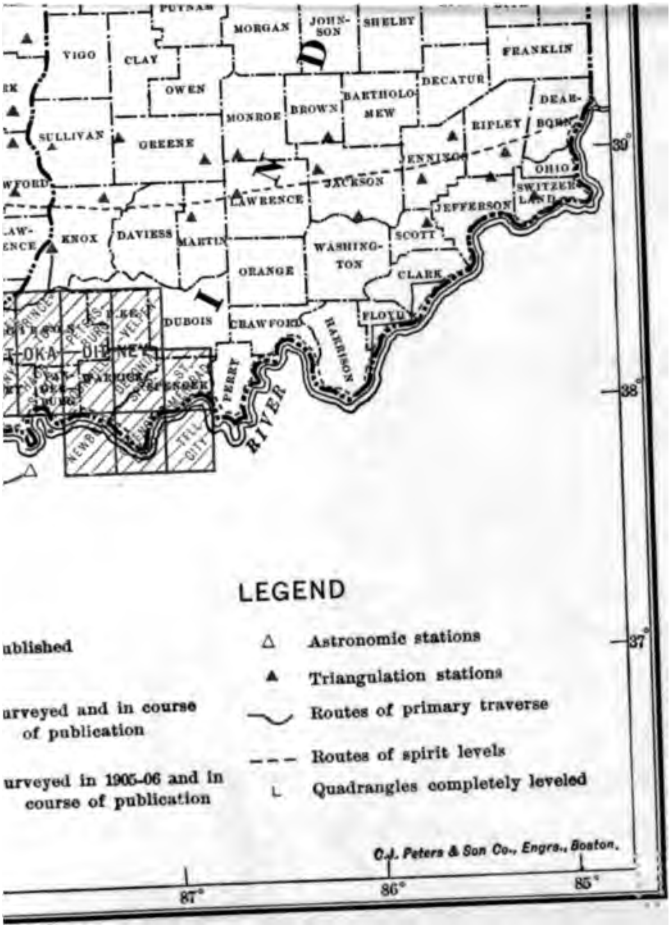
Georgia.—Four parties were engaged in field work during the season. The survey of the Talbotton quadrangle, in Harris, Meriwether, Muscogee, Talbot, Troup, and Upson counties was completed for publication on the scale of 1:125,000, with a contour interval of 50 feet. The mapping of the Kenesaw Battlefield Special—a resurvey of a portion of the Marietta 30-minute quadrangle—on the scale of 5 inches to 1 mile, with a contour interval of 10 feet, was completed. The survey of the Opelika (Alabama-Georgia) quadrangle, in Harris, Muscogee, and Troup counties, was continued, the Georgia portion being completed. The resurvey of the Dahlonega Special quadrangle, in Lumpkin County, for publication on the scale of 1:36,000, with a contour interval of 20 feet, was completed. This special sheet covers portions of the Dahlonega, Ellijay, Suwanee, and Gainesville sheets, previously published on the scale of 1:125,000. The resurvey for the Stilesboro sheet, a reduction of the Cartersville 30-minute sheet, was in progress, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The total new survey made in the field covered 1,310 square miles, during the mapping of which there were run 1,328 miles of spirit levels, in the course of which 54 permanent bench marks and 4,877 elevations were established, and 3,616 linear miles of road traverse were run. The resurvey of 81 square miles in the State was completed, during which 103 trigonometric points were located; 342 miles of spirit levels were run, in the course of which 41 bench marks and 2,129 elevations were established; and 1,088 linear miles of road traverse were run.

Illinois.—The governor of the State of Illinois allotted $10,000 toward cooperative topographic surveys within the State, and the Director of the United States Geological Survey allotted an equal sum to the same work. Three parties were engaged in field work in the State during the season. The survey of the following quadrangles was completed: Belleville, in Madison and St. Clair counties; Eldorado, in Gallatin, Hamilton, Saline, and White counties; Mahomet, in Champaign and Platt counties; New Haven (Illinois-Indiana-Kentucky), in Gallatin and White counties; Springfield, in Logan, Menard, and Sangamon counties; and Urbana, in Champaign County. A partial survey was made of the following quadrangles: Breese, in Bond, Clinton, St. Clair, and Madison counties; Carmi (Illinois-Indiana), in White County; Havana, in Fulton and Mason counties; Petersburg, in Logan, Menard, and Sangamon counties; Saidora, in Cass, Fulton, Mason, and Schuyler counties; and Wheaton, in Dupage County. This work is all for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. In all there were mapped in the above quadrangles 1,347 square miles of the area of the State, and in addition 83 square miles beyond quadrangle limits, which will be incorporated in future map work. There were run 3,740 miles of levels, in the course of which 101 permanent bench marks and 24,446 elevations were established, and 6,223 linear miles of road traverse were run.

Indiana.—Two parties were engaged in field work in the State during the season. The survey of the New Haven (Illinois-Indiana-Kentucky) quadrangle, in Posey County, was completed, and a partial survey was made of the New Albany (Kentucky-Indiana) quadrangle, in Clark, Floyd, and Harrison counties, and of the Prospect (Kentucky-Indiana) quadrangle, in Clark County. There were completed 131 square miles of the area of the State for publication on the scale of 1:62,500, with a contour interval of 20 feet; 202 miles of levels were run, in the course of which 2 permanent bench marks were established; and 166 miles of traverse were run.

Iowa.—Two parties were engaged in field work during the season. The survey of the Des Moines quadrangle, in Polk and Warren counties, and of the Nebraska City (Nebraska-Iowa-Missouri) quadrangle, in Fremont County, was completed. This work is for publication on the scale of 1:62,500, with contour interval of 20 feet. There were mapped in the course of this work 256 square miles in the above-named quadrangles, and in addition 35 square miles beyond quadrangle limits; 587 miles of spirit levels were run, in the course of which 19 permanent bench marks and 4,466 elevations were determined; and 772 miles of linear road traverse were run.

Kentucky.—The director of the State Geological Survey allotted $5,000, and the Director of the United States Geological Survey an equal amount, for cooperative topographic surveys within the State. Three parties were engaged in field work during the season. The survey of the Louisville quadrangle, in Jefferson, Spencer, and Bullitt counties, and of the New Haven (Indiana-Illinois-Kentucky) quadrangle, in Union County, was completed, and a partial survey was made of the following quadrangles: Georgetown, in Fayette, Franklin, Scott, and Woodford counties; Morganfield, in Crittenden, Union, and Webster counties; and Prospect (Kentucky-Indiana), in Bullitt and Jefferson counties. A special map of the city of Louisville was made on the publication scale of 1:24,000, with a contour interval of 20 feet, which will be reduced to form parts of the Louisville, Prospect, Riverview, and New Albany sheets. All of the above work is for publication on the scale of 1:62,500, with a contour interval of 20 feet. In the progress of this work there were mapped 547 square miles of the area of the State; 1,289 miles of levels were run, in the course of which 20 permanent bench marks and 6,928 elevations were determined; and 2,628 linear miles of road traverse were run.



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Louisiana.—One party was engaged during the fall in the survey of the Baton Rouge quadrangle, in West Baton Rouge, East Baton Rouge, Ascension, and Iberville parishes, in the course of which 71 square miles were mapped; 282 miles of spirit levels were run, in connection with which 23 permanent bench marks and 1,165 elevations were determined; and 940 linear miles of road traverse were run. This work is for publication on the scale of 1:62,500, with a contour interval of 10 feet.

Maine.—The State Survey Commission allotted $3,200, and the Director of the United States Geological Survey a like sum, for continuation of cooperative topographic surveys. One party was engaged in the surveys during the season. The mapping of The Forks quadrangle, in Piscataquis and Somerset counties, was completed, and a partial survey was made of the Lewiston quadrangle, in Androscoggin, Kennebec, and Sagadahoc counties, and of the Poland quadrangle, in Androscoggin, Cumberland, and Oxford counties. This work is for publication on the scale of 1:62,500, with a contour interval of 20 feet. There were completely mapped 210 square miles of the State, in connection with which 220 miles of spirit levels were run and 19 permanent bench marks and 875 elevations were determined, and 1,481 linear miles of road traverse were run.

Maryland.—The State geologist of Maryland allotted $2,500 for cooperative topographic surveys within the State, and the Director of the Federal Survey allotted a like amount. One party was engaged in field work within the State. The resurvey of the Relay quadrangle, in Anne Arundel, Baltimore, and Howard counties, was completed, and a partial resurvey was made of the Laurel quadrangle, in Anne Arundel, Howard, Montgomery, and Prince George counties. The revision of the Owensville quadrangle, in Anne Arundel, Calvert, and Prince George counties, and of the Prince Frederick quadrangle, in Anne Arundel, Calvert, Charles, Prince George, and St. Mary counties, was completed. All of the above work is for publication on the scale of 1:62,500, with a contour interval of 20 feet. In all, there were 299 square miles resurveyed or revised; 519 miles of levels were run, in the course of which 63 permanent bench marks and 656 elevations were determined; and 706 linear miles of road traverse were run.

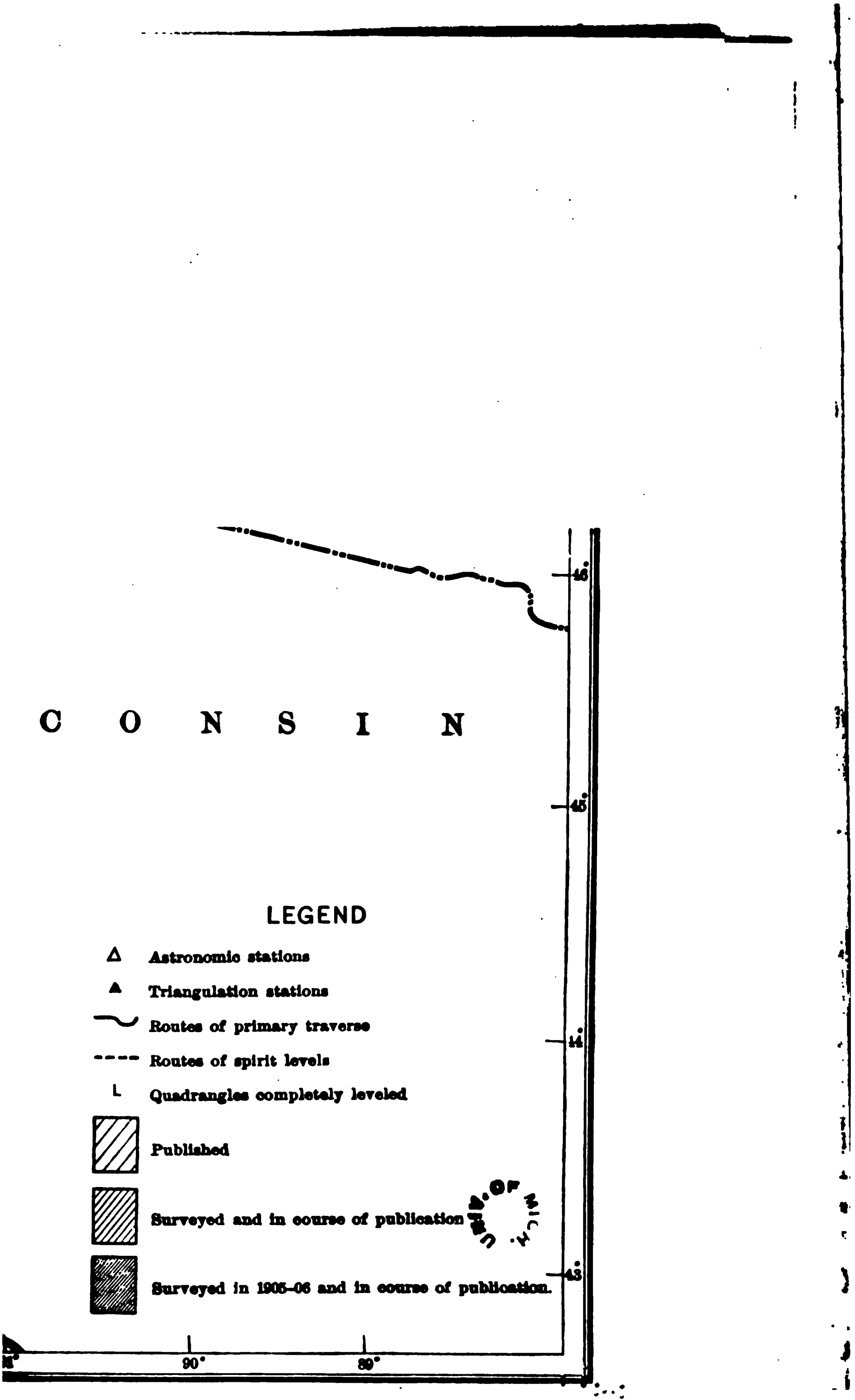
Michigan.—The State geologist allotted $2,000 toward cooperative topographic surveys, and the Director of the United States Geological Survey allotted an equal amount for the same purpose. One party was engaged in field work in the State. The survey of the Marquette quadrangle, in Marquette County, was completed, and a partial survey was made of the Pontiac quadrangle, in Oakland County. The Marquette sheet will be published on the scale of 1:24,000, with a contour interval of 20 feet. There were mapped 47 square miles; 189 miles of spirit levels were run, in the course of which 24 permanent bench marks and 1,256 elevations were determined; and 692 miles of road traverse were run.

Minnesota.—One party was engaged in completing the survey of the Lake Minnetonka quadrangle, in Carver, Hennepin, and Scott counties, for publication on the scale of 1:62,500, with a contour interval of 20 feet. There were mapped 224 square miles within the quadrangle, and in addition 12 square miles beyond the quadrangle limits. There were 592 miles of spirit levels run, in the course of which 24 permanent bench marks and 4,794 elevations were determined, and 797 linear miles of road traverse were run.

Mississippi.—One party was engaged in the field during the fall on the survey of the Jackson quadrangle, in Hinds, Madison, and Rankin counties, which was completed. A partial survey was made of the Florence quadrangle, in Copiah, Hinds, Rankin, and Simpson counties, and of the Raymond quadrangle, in Hinds and Madison counties. This work is for publication on the scale of 1:62,500, with a contour interval of 20 feet. There were 404 square miles of the State's area mapped. Spirit levels to the extent of 355 miles were run, in the course of which 21 permanent bench marks and 1,523 elevations were determined, and 284 linear miles of road traverse were run.

Missouri.—Two parties were engaged in field work in the State during the season. The survey of the Nebraska City (Nebraska-Iowa-Missouri) quadrangle, in Atchison County, was completed, and partial surveys were made of the following quadrangles: Forsyth, in Christian, Stone, and Taney counties; Atlanta, in Knox, Macon, and Shelby counties; Macon, in Macon, Monroe, Randolph, and Shelby counties; Shelbina, in Monroe and Shelby counties, and Shelbyville, in Knox and Shelby counties. The above work is for publication on the scale of 1:62,500, with a contour interval of 20 feet, except the Forsyth, which is for publication on the scale of 1:125,000, with a contour interval of 50 feet. In the course of these surveys 932 square miles were mapped; 98 trigonometric points were located; 1,324 miles of spirit levels were run, in the course of which 56 permanent bench marks and 5,457 elevations were established, and 4,190 linear miles of road traverse were run. Besides the foregoing, the revision of 4 square miles of the De Soto quadrangle, with 82 miles of road traverse, was accomplished, and an addition of 45 miles of spirit levels, with 15 permanent bench marks and 200 elevations, was made.

Nebraska.—One party was engaged in field work in the State in the fall. The survey of the Nebraska City (Nebraska-Iowa-Missouri) quadrangle was completed in Nemaha and Otoe counties, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work resulted in the mapping of 200 square miles. There were run 290 miles of levels, in the course of which 18 permanent bench marks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44
43
90°
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LEGEND
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▲ Triangulation stations
Routes of primary traverse
Routes of spirit levels
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Published
Surveyed and in course of publication
Surveyed in 1905-06 and in course of publication.

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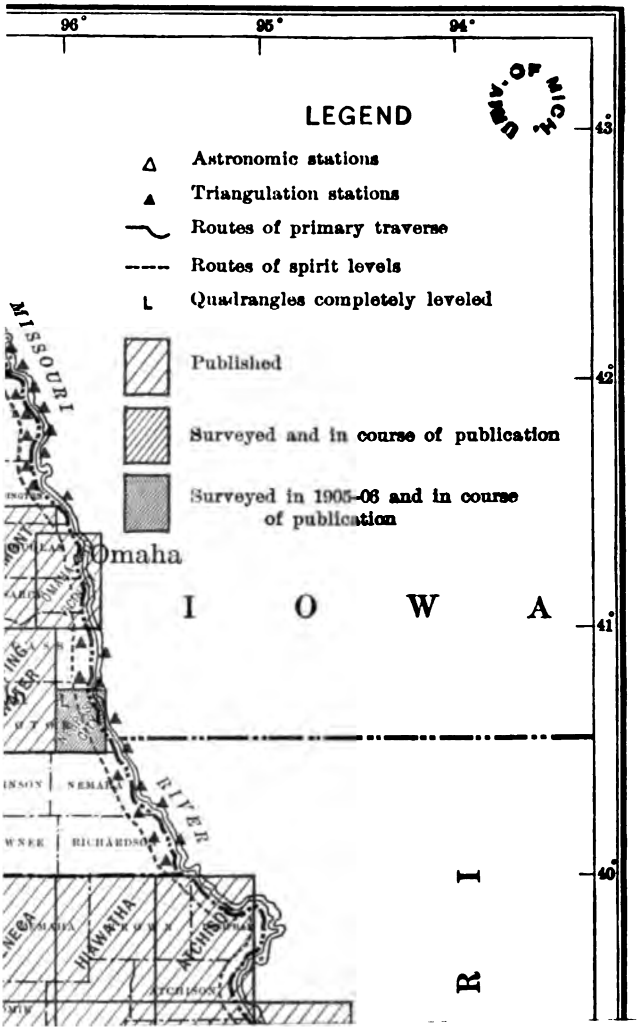
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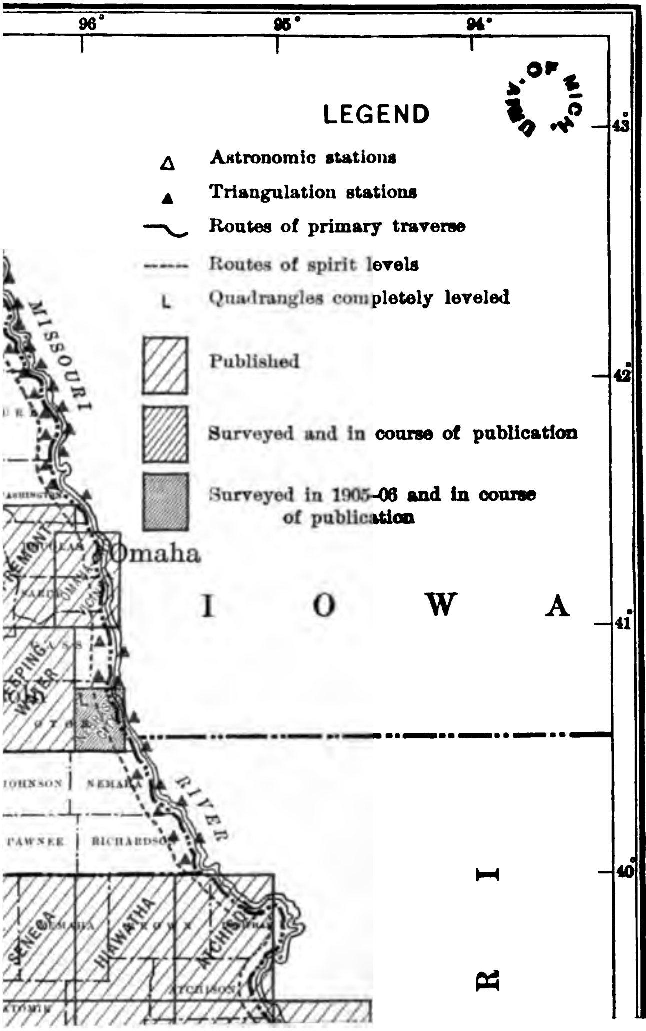
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and 2,060 elevations were determined, and 427 miles of road traverse were run.

New Hampshire.—One party was engaged in field work during the season. An allotment of $400 was made by the forestry commission of New Hampshire for the survey of the Blue Mountain Special quadrangle, and the Director of the United States Geological Survey allotted an equal amount for the same purpose. The Federal Bureau also made surveys on its own behalf. The Blue Mountain Special quadrangle, in Sullivan County, and the Sunapee quadrangle, in Merrimac and Sullivan counties, were completely mapped, and the Hanover (New Hampshire-Vermont) quadrangle, in Grafton and Sullivan counties, and the Windsor (Vermont-New Hampshire) quadrangle, in Sullivan County, were partly surveyed. With the exception of the Blue Mountain Special, this work is for publication on the scale of 1:62,500, with a contour interval of 20 feet. The scale of the Blue Mountain Special was 1:24,000, with 20-foot contours. There were mapped 266 square miles of the area of the State; 204 trigonometric points were located; 394 miles of levels were run, in the course of which 32 permanent bench marks and 1,407 elevations were established; and 1,006 linear miles of road traverse were run.

New York.—The State engineer and surveyor allotted $600 to cooperative topographic surveys, and the Director of the United States Geological Survey allotted $7,000 to the same work. Two parties were engaged in field work in the State during the season, and six during the spring months. The mapping was completed of the following quadrangles: Eden, in Erie and Cattaraugus counties; Port Leyden, in Lewis and Oneida counties; Sangerfield, in Madison, Otsego, and Oneida counties; and Winfield, in Herkimer, Oneida, Otsego, and Madison counties. A partial survey was made of the following quadrangles: Bath, in Steuben County; Cooperstown, in Delaware and Otsego counties; Delhi, in Delaware and Otsego counties; Goshen (New York-New Jersey), in Orange County; Loon Lake, in Franklin County; Monticello, in Orange, Sullivan, and Ulster counties; Port Jervis (New York-New Jersey-Pennsylvania), in Orange County; and Potsdam, in St. Lawrence County. The above work was all on the publication scale of 1:62,500, with a contour interval of 20 feet. A resurvey was made of the Niagara Falls Special, for publication on scale of 1 inch to 200 feet; and earlier work on 3 square miles of the Westfield quadrangle, in Chautauqua County, was revised. The total new survey made in the field covered 1,061 square miles; 757 trigonometric points were located; 964 miles of spirit levels were run, in the course of which 35 permanent bench marks and 3,973 elevations were determined; and 1,887 linear miles of road traverse were run.

A resurvey was made of the crest line of Niagara Falls, 85 trigonometric points being located. (See Bulletin No. 306.)

North Carolina.—The commissioner of agriculture of North Carolina and the Director of the United States Geological Survey each allotted $4,000 to cooperative topographic surveys of certain sheets in the northeastern part of the State. In addition the Federal Survey conducted topographic field work independently in the southwestern part of the State. Four parties were engaged in the partial survey of the Beckford quadrangle, in Chowan, Gates, Hertford, and Perquimans counties; the Four Oaks, in Harnett, Johnston, Sampson, and Wayne counties; the Salemburg, in Sampson County, and the Winton, in Bertie, Gates, and Hertford counties. This work was cooperative, and is on the publication scale of 1:62,500, with a contour interval of 10 feet. There were mapped 386 square miles of the area of the State; 1,153 miles of levels were run, in the course of which 43 permanent bench marks and 4,997 elevations were determined; and 1,797 linear miles of road traverse were run.

In addition to the above, two parties were engaged in noncooperative work in the State. They completed the survey of the Charlotte (North Carolina-South Carolina) quadrangle, in Mecklenburg and Union counties, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In this work 221 square miles of the area of the State were sketched; 393 miles of spirit levels were run, in the course of which 2,037 elevations were established, and 1,215 miles of road traverse were run. The resurvey of the Cowee (North Carolina-South Carolina) quadrangle, in Haywood, Jackson, Macon, Swain, and Transylvania counties, and of the Saluda (North Carolina-South Carolina) quadrangle, in Buncombe, Henderson, McDowell, Polk, and Rutherford counties, was completed. This work is for publication on the scale of 1:125,000, with a contour interval of 100 feet. There were resurveyed 1,149 square miles; 535 trigonometric points were located; 502 miles of levels were run, in the course of which 3,074 elevations were established; and 928 linear miles of road traverse were run..

North Dakota.—One party was engaged in field work, completing the survey of the Bismarck quadrangle, in Burleigh, Emmons, Morton, and Oliver counties. This is for publication on the scale of 1:125,000, with a contour interval of 50 feet. There were mapped 820 miles of the above quadrangle, and in addition 21 square miles beyond the limits of the quadrangle for incorporation in future map work. In this work 75 trigonometric points were located; 906 miles of spirit levels were run, in the course of which 31 permanent bench marks and 3,495 elevations were determined; and 1,124 linear miles of road traverse were run.

Ohio.—The governor of the State of Ohio and the Director of the United States Geological Survey each allotted $23,800 toward coopera-

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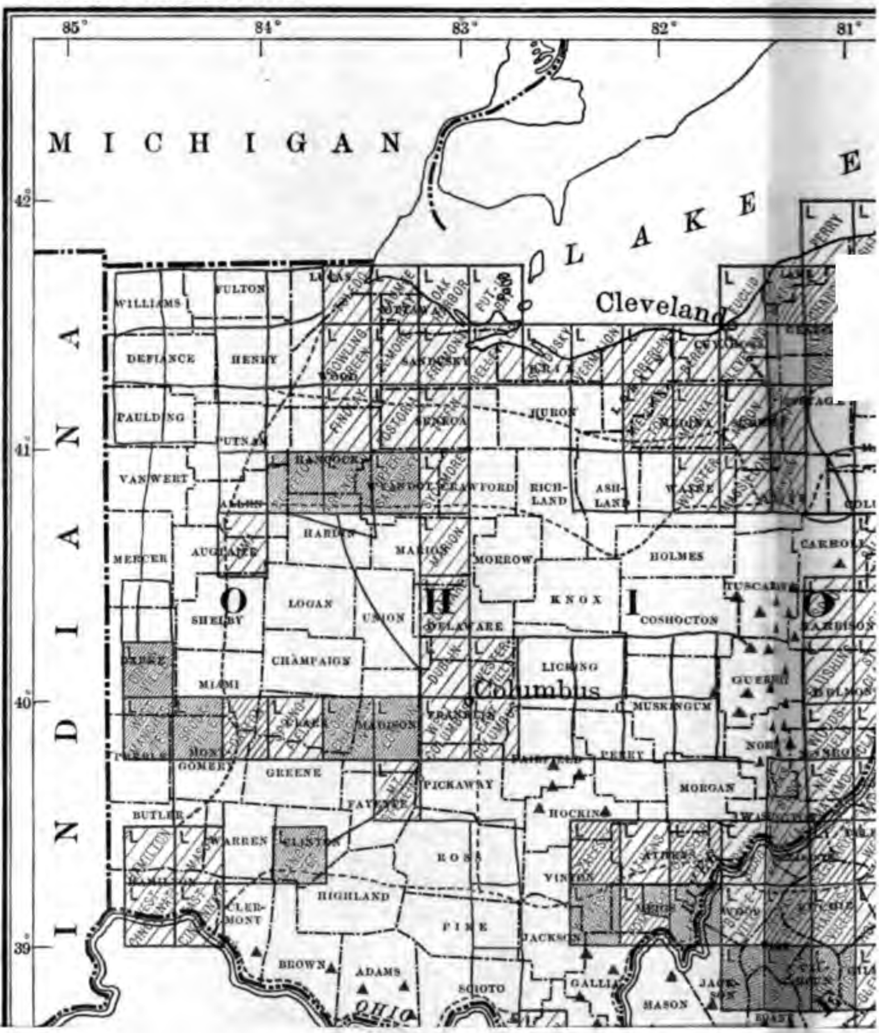


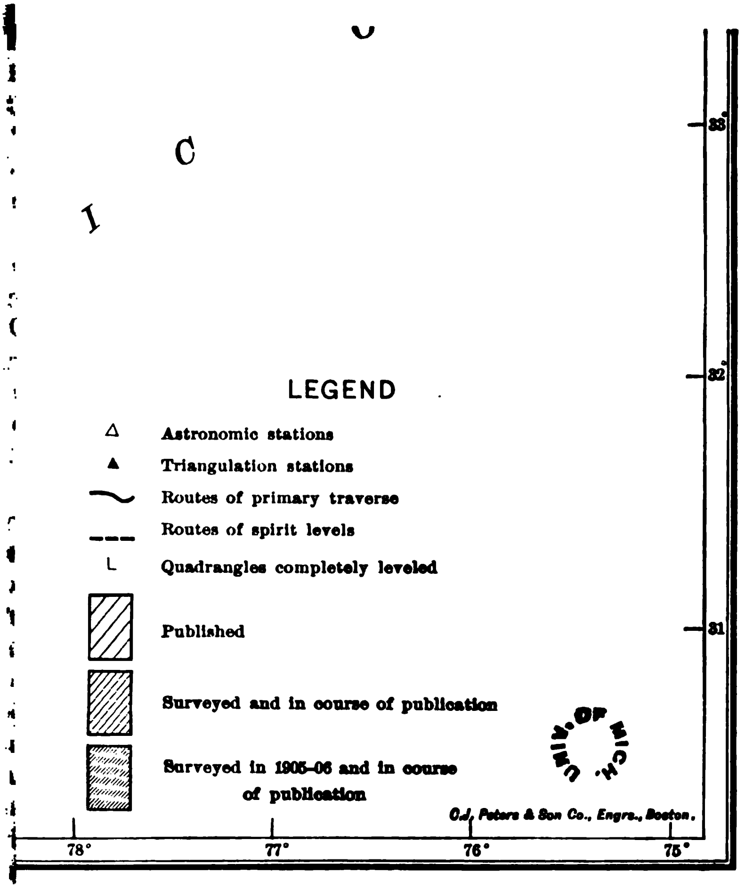
tive topographic work in the State. Nine parties were engaged in field work. The survey was completed of the following quadrangles: Andover (Ohio-Pennsylvania), in Ashtabula County; Arlington, in Hancock, Hardin, and Wyandot counties; Blanchester, in Clinton, Highland, and Warren counties; Bluffton, in Allen, Hancock, Hardin, and Putnam counties; Bristolville, in Trumbull County; Brookville, in Darke, Miami, and Montgomery counties; Garrettsville, in Geauga, Portage, and Trumbull counties; Greenville, in Darke County; Jefferson, in Ashtabula County; Keno (Ohio-West Virginia), in Athens and Meigs counties; Kinsman (Ohio-Pennsylvania), in Trumbull County; London, in Madison County; Pomeroy (Ohio-West Virginia), in Athens, Meigs, and Gallia counties; South Charleston, in Clark, Greene, and Madison counties; Upper Sandusky, in Hancock, Seneca, and Wyandot counties; West Manchester, in Darke and Preble counties; and Wilkesville, in Athens, Gallia, Jackson, Meigs, and Vinton counties. A partial survey was made of the following quadrangles: Athalia (Ohio-West Virginia), in Gallia and Lawrence counties; Ashland, in Ashland and Richland counties; Bidwell, in Gallia, Jackson, and Lawrence counties; Chagrin Falls, in Geauga, Cuyahoga, Summit, and Portage counties; Chillicothe, in Ross and Pickaway counties; Columbus Grove, in Allen and Putnam counties; Glenwood (West Virginia-Ohio), in Lawrence County; Loramie, in Auglaize, Darke, Mercer, and Shelby counties; Middletown, in Butler, Montgomery, and Warren counties; New London, in Ashland, Huron, and Lorain counties; Point Pleasant (Ohio-West Virginia), in Gallia County; Ravenna, in Portage, Mahoning, and Trumbull counties; Ravenswood (West Virginia-Ohio), in Meigs County; St. Henry, in Mercer and Darke counties; Warren, in Trumbull and Mahoning counties; Waverly, in Jackson, Pike, Ross, and Vinton counties; West Salem, in Ashland, Medina, and Wayne counties; and Youngstown (Ohio-Pennsylvania), in Trumbull and Mahoning counties. This work is all for publication on the scale of 1:62,500, with contours of 10 and 20 feet interval. In all, there were mapped 3,721 square miles of the area of the State; 194 trigonometric points were located; 8,622 miles of levels were run, in the course of which 236 permanent bench marks and 44,959 elevations were determined; and 10,425 linear miles of road traverse were run. In addition, earlier work on 122 square miles of the Mentor quadrangle and on 2 square miles of the Sandusky quadrangle was revised, with 8 miles of road traverse, and check levels to the extent of 29 miles were run in the Medina and Wellington quadrangles.

Pennsylvania.—The State Survey Commission of Pennsylvania allotted $14,000 toward cooperative topographic surveys, and the Director of the United States Geological Survey allotted an equal amount for the same purpose. Seven parties were engaged in field work during the season. The survey of the following quadrangles was completed: Andover (Ohio-Pennsylvania), in Crawford County; Claysville, in Washington County; Kinsman (Ohio-Pennsylvania), in Crawford and Mercer counties; Millerstown, in Juniata, Snyder, and Perry counties; Neshannock, in Lawrence and Mercer counties; New Cumberland, in Cumberland, Dauphin, and York counties; and Honeybrook, in Berks, Chester, and Lancaster counties. The survey of the following quadrangles was unfinished in the field: Clarion, in Armstrong and Clarion counties; Middletown, in Dauphin, Lancaster, Lebanon, and York counties; New Holland, in Berks and Lancaster counties; Port Jervis (New York-New Jersey-Pennsylvania), in Pike County; Sewickley, in Allegheny, Beaver, and Butler counties; and Warren, in Warren County. This work is for publication on the scale of 1:62,500, with a contour interval of 20 feet. In all, there were completely mapped 1,286 square miles of the area of the State; 163 trigonometric locations were determined; 2,958 miles of spirit levels were run, in the course of which there were established 109 permanent bench marks and 13,631 elevations; and 6,397 miles of road traverse were run. The resurvey was completed of 48 square miles of the Pennsylvania portion of the Lambertville (New Jersey-Pennsylvania) quadrangle, and 99 additional miles of road traverse were run in the Ebensburg, Barnesboro, Hollidaysburg, and Houtzdale quadrangles.

South Carolina.—Two parties were engaged in field work during the season. The survey of the Charlotte (North Carolina-South Carolina) quadrangle, in York County, and of the Sharon quadrangle, in Chester, Cherokee, York, and Union counties, was completed for publication on the scale of 1:62,500, with a contour interval of 20 feet; also the resurvey of the Saluda (North Carolina-South Carolina) quadrangle, in Spartanburg and Greenville counties, and of the Cowee (North Carolina-South Carolina) quadrangle, in Oconee County, for publication on the scale of 1:125,000, with a contour interval of 100 feet. There were mapped 312 square miles of new survey and 143 square miles of resurvey; 1,402 miles of levels were run, during which 27 permanent bench marks and 8,854 elevations were determined; and 1,278 miles of road traverse were run.

Vermont.—One party was engaged in the partial survey of the Hanover (New Hampshire-Vermont) quadrangle, in Windsor County, on the publication scale of 1:62,500, with a contour interval of 20 feet. There were located 92 trigonometric points; 66 miles of spirit levels were run, in the course of which 11 permanent bench marks and 338 elevations were determined; and 101 linear miles of road traverse were run.

Virginia.—One party was engaged in field work in the State. The survey of the Yorktown quadrangle, in James City, Surry, and War-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F TOPOGRAPHIC SURVEYING

wick counties, was completed for publication on the scale of 1:62,500, with a contour interval of 10 feet. There were sketched 49 square miles within the quadrangle and 17 square miles beyond its limits, which will be incorporated in future map work; 231 miles of levels were run, in the course of which 10 permanent bench marks and 1,112 elevations were determined; and 320 linear miles of road traverse were run. The resurvey of the Fincastle quadrangle, in Botetourt and Craig counties, and of the Natural Bridge quadrangle, in Botetourt and Rockbridge counties, was not finished; 9 square miles were resurveyed; 92 trigonometric points were located; 259 miles of levels were run, in the course of which 28 permanent bench marks and 853 elevations were determined; and 444 linear miles of road traverse were run. This work was on the publication scale of 1:62,500, with a contour interval of 50 feet.

West Virginia.—The State geologist of West Virginia allotted $15,000 and the Director of the United States Geological Survey a like amount for cooperative topographic surveys within the State. Five parties were engaged in topographic surveys in the State during the season. The survey of the following quadrangles was completed: Arnoldsburg, in Calhoun, Gilmer, and Wirt counties; Keno (Ohio-West Virginia), in Jackson County; Pomeroy (Ohio-West Virginia), in Mason and Wirt counties; Ripley, in Jackson, Roane, and Wirt counties; and Spencer, in Calhoun, Roane, and Wirt counties. The following quadrangles were partially surveyed: Glenwood (West Virginia-Ohio), in Cabell, Mason, and Putnam counties; Point Pleasant (Ohio-West Virginia), in Mason County; and Ravenswood (West Virginia-Ohio), in Jackson and Mason counties. This work is for publication on the scale of 1:62,500; contour interval, 20 feet. The resurvey of the following quadrangles was completed: Belington, in Barbour, Randolph, and Tucker counties; Kingwood, in Preston County; and Thornton, in Monongalia, Preston, Marion, Taylor, and Barbour counties. The resurvey of the following quadrangles was in progress: Davis (West Virginia-Maryland), in Grant, Preston, and Tucker counties; Elkins, in Barbour and Randolph counties; and Parsons, in Preston, Randolph, and Tucker counties. This work is on the publication scale of 1:62,500, with a contour interval of 20 feet. There were surveyed of the area of the State 713 square miles; 406 points were located by trigonometric methods; 1,220 linear miles of levels were run, in the course of which 69 permanent bench marks and 4,598 elevations were determined; and 4,242 linear miles of road traverse were run. A total of 704 square miles was resurveyed, during which 322 trigonometric points were located; 1,283 miles of spirit levels were run, in the course of which 57 permanent bench marks and 4,914 elevations were determined; and 2,839 linear miles of road traverse were run. In addition, some revision work was done in the Glenville and

Oakland quadrangles, consisting of 13 square miles of resketching, 3 trigonometric locations, 43 miles of levels, with 90 additional elevations, and 48 linear miles of road traverse.

Wisconsin.—Two parties were engaged in field work during the season. The survey of the following quadrangles was in progress: Cross Plains, in Dane County; Mazomanie, in Dane, Iowa, and Sauk counties; and Sparta, in La Crosse and Monroe counties. This work is for publication on scale of 1:62,500, with a contour interval of 20 feet. There were mapped 5 square miles of new territory; 74 trigonometric points were located; 332 miles of spirit levels were run, in the course of which 51 permanent bench marks and 2,106 elevations were determined; and 602 linear miles of road traverse were run. The resurvey of the Sun Prairie quadrangle, in Dane, Dodge, and Jefferson counties, was completed. In connection with this resurvey 218 square miles were sketched; 48 points were located by trigonometric methods; 372 miles of spirit levels were run, in the course of which 11 permanent bench marks and 1,738 elevations were determined; and 433 linear miles of road traverse were run. This work is on the publication scale of 1:62,500, with a contour interval of 20 feet. In addition, correction work consisting of 24 miles of road traverse was done in the Mineral Point quadrangle.

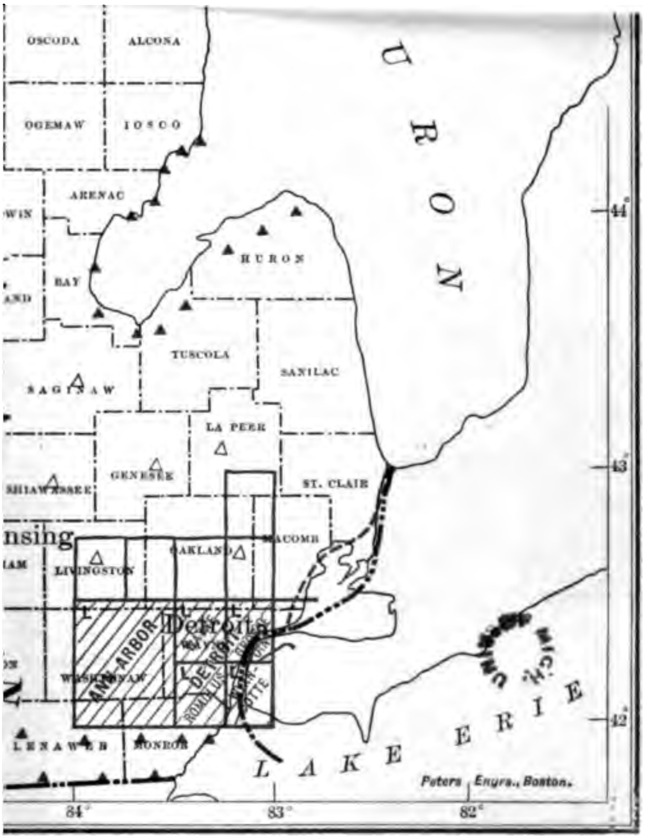
OFFICE DRAFTING.

Alabama.—The drafting of the Bessemer Special and Leeds sheets was completed, and they are being engraved on the scale of 1:62,500, with a contour interval of 20 feet. About 30 per cent of the office drafting of the Bessemer sheet was completed; scale 1:125,000, contour interval 50 feet.

Georgia.—The drafting of the Dahlonega Special sheet was completed, for engraving on the scale of 1:36,000, contour interval 20 feet; also of the Kenesaw Battlefield Special sheet, for engraving on the scale of 5 inches to 1 mile, contour interval 10 feet; the Cartersville Special sheet, for engraving on the scale of 1:62,500, contour interval 20 feet, and the Talbotton sheet, for engraving on the scale of 1:125,000, contour interval 50 feet. About 15 per cent of the office drafting of the unfinished Stilesboro sheet was completed, scale 1:62,500, contour interval 50 feet, and about 50 per cent of the Opelika (Georgia-Alabama) sheet, scale 1:125,000, contour interval 50 feet.

Illinois.—The drafting of the Belleville, Eldorado, Mahomet, Springfield, and Urbana sheets was completed, for engraving on the scale of 1:62,500, with contour intervals of 10 and 20 feet. About 30 per cent of the office drafting of the Breese and Wheaton sheets was completed, scale 1:62,500, contour interval 10 feet.

Indiana.—The drafting of the New Haven (Indiana-Kentucky-Illinois) sheet was completed, for engraving on the scale of 1:62,500,



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with a contour interval of 20 feet. About 6 per cent of the drafting of the New Albany (Indiana-Kentucky) sheet was completed, on the same scale and with the same contour interval.

Iowa.—The drafting of the Des Moines sheet was completed, for engraving on the scale of 1:62,500, with a contour interval of 20 feet.

Kentucky.—The drafting of the Louisville sheet, for engraving on the scale of 1:62,500, contour interval 20 feet, was completed; also of the city of Louisville sheet, scale 1:24,000, contour interval 20 feet; and in addition about 80 per cent of the office drafting of the Georgetown, 25 per cent of the Morganfield, 52 per cent of the Prospect, and 4 per cent of the Riverview sheets, all on the scale 1:62,500, contour interval 20 feet.

Louisiana.—About 25 per cent of the drafting of the Baton Rouge sheet was completed, on the scale of 1:62,500, contour interval 10 feet.

Maine.—The drafting of The Forks sheets, for engraving on the scale of 1:62,500, contour interval 20 feet, was completed.

Maryland.—The drafting of the Owensville and Prince Frederick revised sheets, and of the resurveyed Relay sheet, for engraving on the scale of 1:62,500, with contour intervals of 20 feet, was completed; also about 30 per cent of the drafting of the finished portion of the resurveyed Laurel sheet, scale 1:62,500, contour interval 20 feet.

Michigan.—The drafting of the Marquette sheet, for engraving on the scale of 1:24,000, with a contour interval of 20 feet, was completed.

Minnesota.—The drafting of the Lake Minnetonka sheet, for engraving on the scale of 1 : 62,500, contour interval 20 feet, was completed.

Mississippi.—The drafting of the Jackson sheet, scale 1 : 62,500, contour interval 20 feet, was completed; also about 30 per cent of the office drafting of the unfinished Florence, Raymond, and Terry sheets, scale 1 : 62,500, contour interval 20 feet.

Missouri.—The readjustment of the De Soto sheet was completed, for engraving on the scale of 1 : 125,000, with a contour interval of 50 feet. Drafting of unfinished sheets progressed to the following stages: Atlanta, 30 per cent; Macon, 30 per cent; Shelbyville, 28 per cent; Shelbina, 28 per cent; all on the scale 1 : 62,500, contour interval 20 feet. Of the unfinished Forsyth sheet 85 per cent of the office drafting was completed; scale 1 : 125,000, contour interval 50 feet.

Nebraska.—The drafting of the Nebraska City (Nebraska-Iowa-Missouri) sheet was completed, for engraving on the scale of 1 : 62,500, with contour interval of 20 feet.

New Hampshire.—The drafting of the Blue Mountain Special sheet was completed, for engraving on the scale of 1 : 24,000, with a contour interval of 20 feet; also of the Sunapee sheet, for engraving on the scale of 1 : 62,500, with a contour interval of 20 feet.

New York.—The drafting of the Eden, Port Leyden, Sangerfield, and Winfield sheets, for engraving on the scale of 1:62,500, with a contour interval of 20 feet, was completed, and drafting of unfinished sheets progressed as follows: Cooperstown, 5 per cent; Loon Lake, 50 per cent; Potsdam, 5 per cent, and Port Jervis, 10 per cent, all same scale and contour interval.

New Jersey.—The drafting of the resurveyed Pennsylvania portion and of the revised New Jersey portion of the Lambertville (New Jersey-Pennsylvania) sheet was completed, for engraving on the scale of 1:62,500, with a contour interval of 20 feet.

North Carolina.—The drafting of the Charlotte (North Carolina-South Carolina) sheet, for engraving on the scale of 1:62,500, with a contour interval of 20 feet, was completed; also of the resurvey of the Cowee (North Carolina-South Carolina) and the Saluda (North Carolina-South Carolina) sheets, scale 1:125,000, contour interval 100 feet. In addition, about 90 per cent of the Beckford, 60 per cent of the Four Oaks, and 2 per cent of the Salemburg sheets were finished, scale 1:62,500, contour interval 10 feet.

North Dakota.—The drafting of the Bismarck sheet, for engraving on the scale of 1:125,000, with a contour interval of 50 feet, was completed.

Ohio.—The drafting of the Andover, Arlington, Blanchester, Bluffton, Bristolville, Brookville, Garrettsville, Greenville, Jefferson, Keno (Ohio-West Virginia), Kinsman (Ohio-Pennsylvania), London, South Charleston, Upper Sandusky, West Manchester, and Wilkesville sheets, for engraving on the scale of 1:62,500, with contour interval of 10 or 20 feet, was completed. The Mentor sheet was resketched for engraving on the scale of 1:62,500, with a contour interval of 20 feet. Thirty per cent of the drafting of the unfinished Athalia, Bidwell, Chagrin Falls, Chillicothe, Columbus Grove, Middletown, New London, Ravenna, St. Henry, Warren, Waverly, West Salem, and Youngstown sheets was completed; scale 1:62,500, contour interval 10 or 20 feet.

Pennsylvania.—The drafting of the Claysville, Millerstown, New Cumberland, and Neshannock sheets, for engraving on the scale of 1:62,500, with a contour interval of 20 feet, was completed; also drafting of unfinished sheets as follows: 55 per cent of the Clarion, 30 per cent of each of the three sheets Middletown, New Holland, and Sewickley, and 25 per cent of the Warren, all on the scale of 1:62,500, with a contour interval of 20 feet.

South Carolina.—The drafting of the Sharon sheet, for engraving on scale of 1:62,500, with a contour interval of 20 feet, was completed.

Virginia.—The drafting of the Yorktown sheet, for engraving on the scale of 1:62,500, with a contour interval of 10 feet, was completed; also about 20 per cent of the office drafting of the Natural Bridge sheet, scale 1:62,500, contour interval 20 feet.

West Virginia.—The drafting on the Arnoldsburg, Belington, Kingwood, Ripley, and Spencer sheets, for engraving on the scale of 1:62,500, contour interval of 20 feet, was completed; also drafting of unfinished sheets as follows: Glenwood, 25 per cent; Point Pleasant and Ravenswood, 30 per cent; Thornton, 80 per cent.

Wisconsin.—The drafting of the Sun Prairie sheet, for engraving on the scale of 1:62,500, with a contour interval of 20 feet, was completed; also drafting of unfinished sheets as follows: Cross Plains and Mazomanie, 5 per cent; Sparta, 20 per cent; all on the above scale and with the same contour interval.

WESTERN DIVISION.

FIELD WORK.

SUMMARY.

Under the combined allotments for topography and forestry topographic work was done during the year in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming. This resulted in the completion of 21 quadrangles, 5 special maps, and 2 large reconnaissance maps, and in the partial survey of 24 quadrangles. The total new area surveyed was 21,745 square miles, of which 2,674 square miles were for publication on the scale of 1:62,500; 8,831 square miles were for publication on the scale of 1:125,000; and 10,240 square miles were for publication on the scale of 1:250,000. In addition, 1,016 square miles were resurveyed, of which 457 square miles were for publication on the scale of 1:125,000; 204 square miles were for publication on the scale of 1:62,500; 234 square miles were for publication on the scale of 1:48,000, and 121 square miles were for publication on the scale of 1:24,000. In connection with this work 4,717 miles of spirit levels were run and 1,290 permanent bench marks were established. Forest-reserve boundary surveys were carried on in California and Utah—in the Sierra, Stanislaus, and Santa Barbara reserves of California, and in the Logan and Payson reserves of Utah, the Payson boundary being completed. A total of 327 miles of boundary were run, 12 miles were retraced, and 15 miles of supplemental lines were run.

Topographic surveys in western division from May 1, 1905, to April 30, 1906.

State.	Contour interval.	Scale of publication.				Total area surveyed.	Levels.	
		1:125,000.		1:62,500.			Distance run.	Bench marks.
		New.	Resurvey.	New.	Resurvey.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Arizona	50, 100	655	....	45	....	[a, b] 1,009	193	59
California	5, 10, 20, 50, 100	2,285	31	1,148	....	[c, d] 6,517	941	206
Colorado	20, 100	784	....	437	....	1,221	383	102
Idaho	50, 100	258	....	....	....	[b] 263	134	27
Montana	100	856	....	....	....	856	327	94
Nevada	20, 100	....	....	....	....	[d] 7,286	255	45
New Mexico	....	....	....	....	....	....	693	238
Oklahoma	20	....	....	356	....	356	516	157
Oregon	50, 100	2,155	....	....	....	[b] 2,255	405	100
South Dakota	20	....	....	329	....	329	....	....
Texas	20	321	....	....	....	321	22	4
Utah	50, 100	....	426	93	204	[e] 745	194	49
Washington	20, 50	314	....	191	....	505	245	56
Wyoming	100	1,098	....	....	....	1,098	409	153
		8,726	457	2,599	204	22,761	4,717	1,290

[a] 234 square miles for publication on scale of 1:48,000.

[b] 5 square miles Mitchell Butte sheet in Idaho and 100 square miles in Oregon mapped by Reclamation Service for publication on scale of 1:125,000; also 75 square miles in Arizona for publication on scale of 1:62,500.

[c] 45 square miles resurvey for publication on scale of 1:24,000.

[d] 3,008 square miles in California and 7,232 square miles in Nevada for publication on scale of 1:250,000, and 54 square miles resurvey in Nevada for publication on scale of 1:24,000.

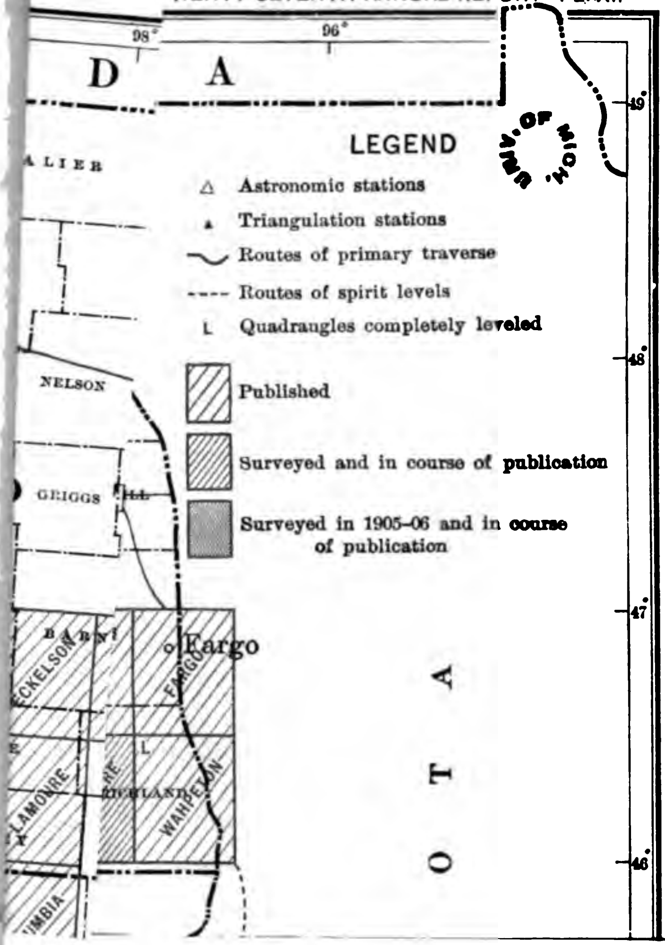
[e] 22 square miles resurvey for publication on scale of 1:24,000.

GENERAL TOPOGRAPHIC WORK, BY STATES.

Arizona.—One party was engaged in the completion of the survey of the Sacaton quadrangle, in Pinal and Maricopa counties. The area surveyed was 45 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. In addition, 75 square miles of this quadrangle were previously mapped by the Reclamation Service.

California.—Part of the topographic work in California was carried on under a renewal of the agreement of previous years between the Director of the United States Geological Survey and the State board of examiners, the amount allotted by each being $15,000.

The cooperative work was principally in the Sacramento Valley, where the Woodland, Davisville, Dunnigan, and Colusa quadrangles, in Yolo, Sacramento, Sutter, and Colusa counties, were completed. These quadrangles comprise an area, mapped this year, of 788 square miles, and in connection with the survey of the Davisville quadrangle 46 miles of levels were run and 9 permanent bench marks established. In addition, four quadrangles, the Rumsey, Capay, Grimes, and Knights Landing, were partially surveyed, the area covered being 164 square miles, in Colusa, Sutter, and Yolo counties. In connection with the survey of the Knights Landing quadrangle 10 miles of levels were run and 3 permanent bench marks established. In this locality, for the control of future sketching, 106 miles of levels were run and 23 permanent bench marks established; 40 miles of check levels also were run. All of the Sacramento Valley work was mapped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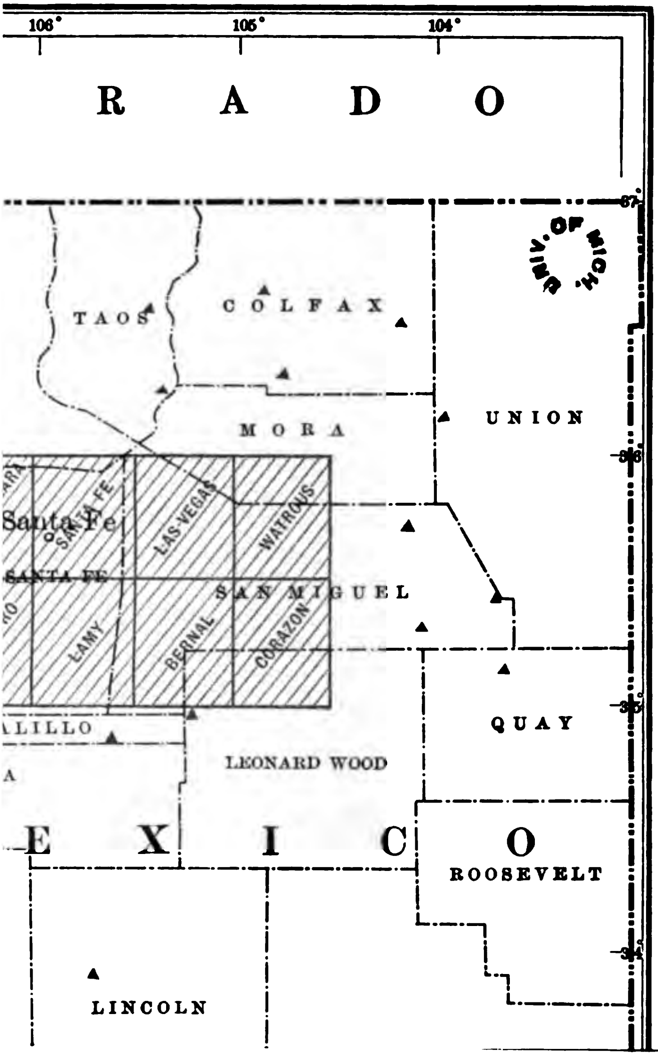
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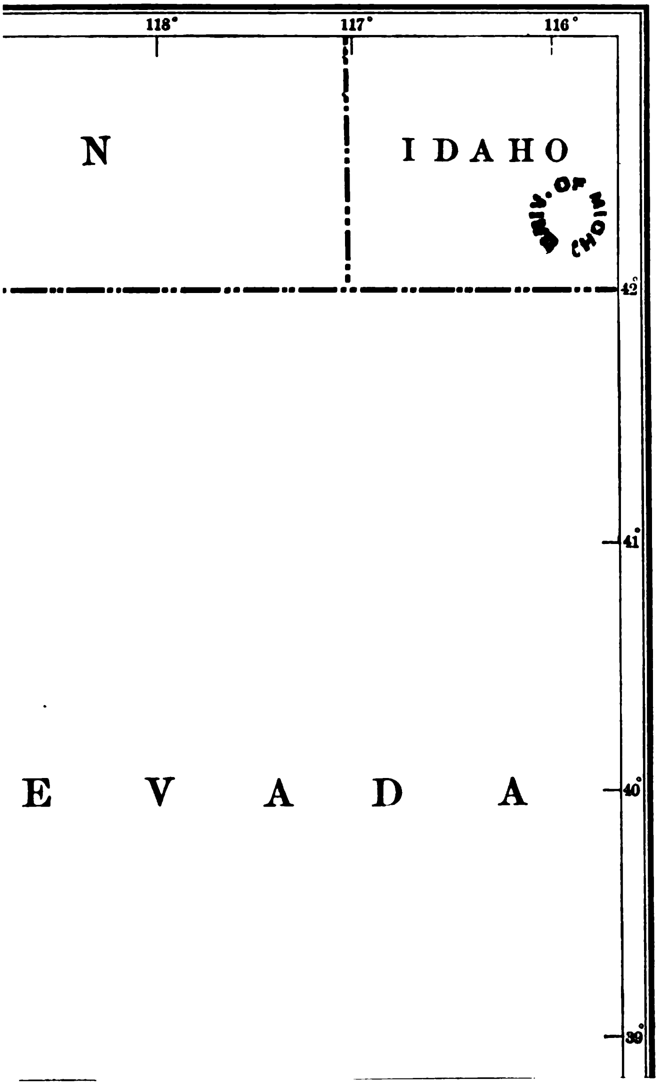

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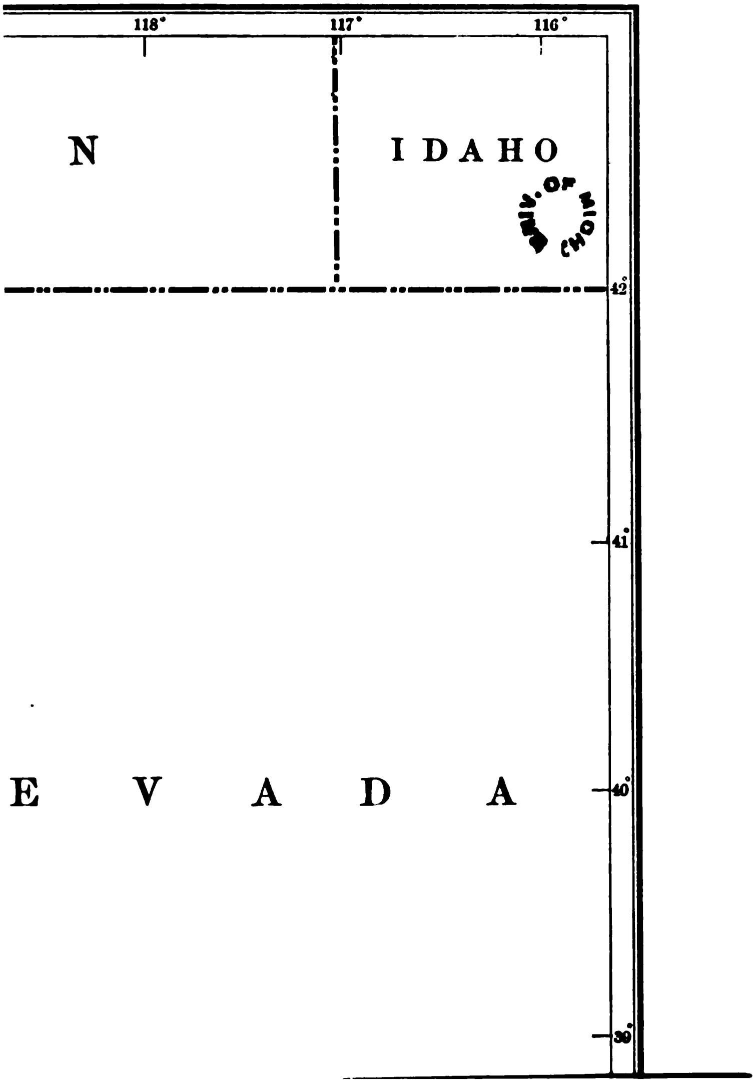

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for publication on the scale of 1:62,500, with a contour interval of 5 feet, the field surveys being on a scale of 2 inches to the mile; a limited edition of the maps was published on this scale also.

As part of the cooperative work, a special map of the Yosemite National Park, in Mariposa County, was commenced. The area mapped was 45 square miles, for publication on the scale of 1:24,000, with a contour interval of 100 feet. In connection with this work 218 miles of traverse were run.

In addition to the cooperative work, two parties were engaged in the survey of the Tesla quadrangle, in Alameda and San Joaquin counties, and of the Holtville quadrangle, in San Diego County, which was completed. Of the Tesla quadrangle 196 square miles were mapped for publication on the scale of 1:62,500, with a contour interval of 50 feet, in connection with which 54 miles of levels were run, 8 permanent bench marks established, and 274 miles of traverse line run. Of the Holtville quadrangle 100 square miles were mapped for publication on the scale of 1:125,000, with a contour interval of 20 feet, in connection with which 53 miles of traverse line were run. The revision of a small area in the Santa Cruz quadrangle was also completed, 31 square miles being mapped for publication on the scale of 1:125,000, with a contour interval of 100 feet, for which 122 miles of traverse line were run.

As a basis for future topographic work, leveling was commenced by two parties from Keeler northward and southward for the control of the Death Valley and other adjoining regions. The work of the combined parties consisted of 234 miles of level lines, in connection with which 42 permanent bench marks were established, 54 miles of check line in addition being run.

One party was engaged in a reconnaissance survey of the Imperial Valley and Salton Sink, in San Diego and Riverside counties. The area mapped was 1,685 square miles, for publication on the scale of 1:500,000, with a contour interval of 50 feet, in connection with which 277 miles of traverse line were run.

A summary of work done under the appropriation for topography in California is as follows: 3,009 square miles mapped; 450 miles of levels run; 104 miles of check levels run; 85 permanent bench marks established; 1,034 miles of traverse line run. This summary does not include an area of 1,323 square miles, embracing a portion of Death Valley, surveyed in connection with work in Nevada and reported elsewhere.

Colorado.—One party was engaged in topographic work, and completed the mapping of the Mount Olympus quadrangle, consisting of 228 square miles, and parts of the Loveland and Fort Collins quadrangles, the area mapped being 209 square miles. The work was for publication on the scale of 1:62,500, with a contour interval of 20 feet, except the Mount Olympus quadrangle, where a contour interval of 100 feet was used. All of this work is in Boulder, Larimer, and Greeley counties, and in connection with it 1,578 miles of traverse were run. For the control of this and other areas 383 miles of levels were run and 98 permanent bench marks were established.

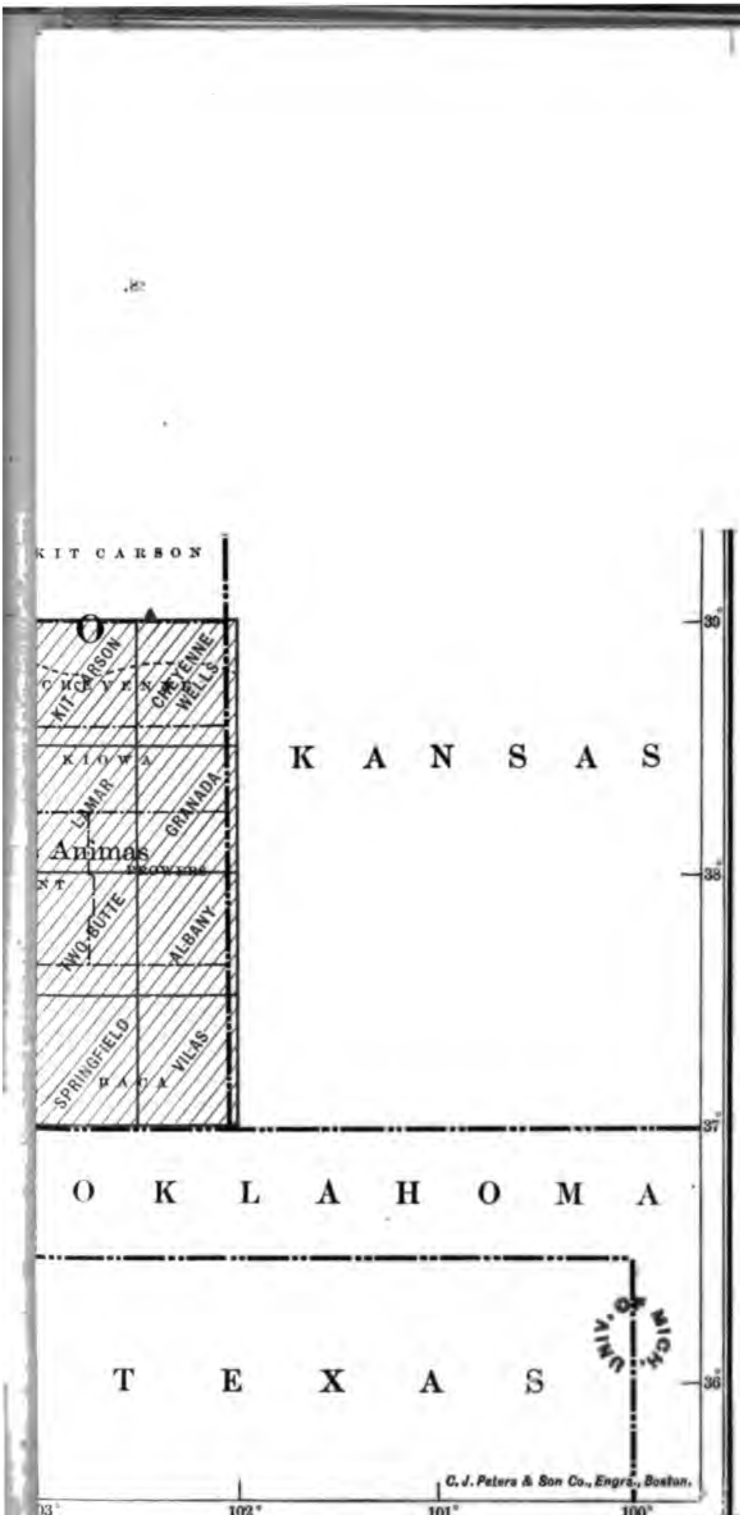
Montana.—For the control of the Moccasin Mountain and adjoining quadrangles, in Fergus County, a system of level lines, 111 miles in length, with 33 permanent bench marks, was run from a bench mark on Missouri River.

Nevada.—Two parties were engaged in the survey of the Goldfield and Bullfrog Special quadrangles, in parts of Nye and Esmeralda counties. The area mapped included 31 square miles of the Goldfield and 23 square miles of the Bullfrog Special, for publication on the scale of 1:24,000, with a contour interval of 20 feet. In connection with this work 255 miles of levels were run, 45 permanent bench marks were established, and 176 miles of traverse lines were run.

Nevada-California.—One party was engaged in a reconnaissance survey in Esmeralda County, Nev., and Inyo County, Cal. The area mapped, which is called the Amargosa region, was 1,323 square miles in California and 7,232 square miles in Nevada, for publication on the scale of 1:250,000, with a contour interval of 100 feet.

New Mexico.—For completing the vertical control of the Magdalena quadrangle, in Socorro County, 82 miles of level lines were run and 15 permanent bench marks were established. A line of precise levels along the Santa Fe Railway from Albuquerque to El Paso, with a branch line to Silver City, was run, covering 196 miles, in connection with which 79 permanent bench marks were set. By the courtesy of the officials of the Santa Fe Railway Company permission was granted for the use of velocipede cars by the party, which greatly expedited the work. The best record for a single day's standard leveling by an employee of the Geological Survey was made on this line on October 21, when 9 miles of checked line were completed, requiring a total run of a trifle over 18 miles.

Oklahoma.—Topographic work in Oklahoma was carried on under an agreement between the Director of the United States Geological Survey and a survey commission of the Territory of Oklahoma consisting of Governor T. B. Ferguson, Attorney-General P. C. Simons, and the secretary of the board of agriculture, C. A. McNabb. By the terms of the cooperative agreement, to the $5,000 appropriated by the Territory was added an equal amount from the Federal appropriation for the Geological Survey, thus making the sum of $10,000 available for cooperative work. Topographic surveys were carried on by one party over the entire Chandler quadrangle and parts of the Mallon, Agra, and Sac and Fox quadrangles, all in Lincoln County. The total area surveyed was 356 square miles, for publication on the



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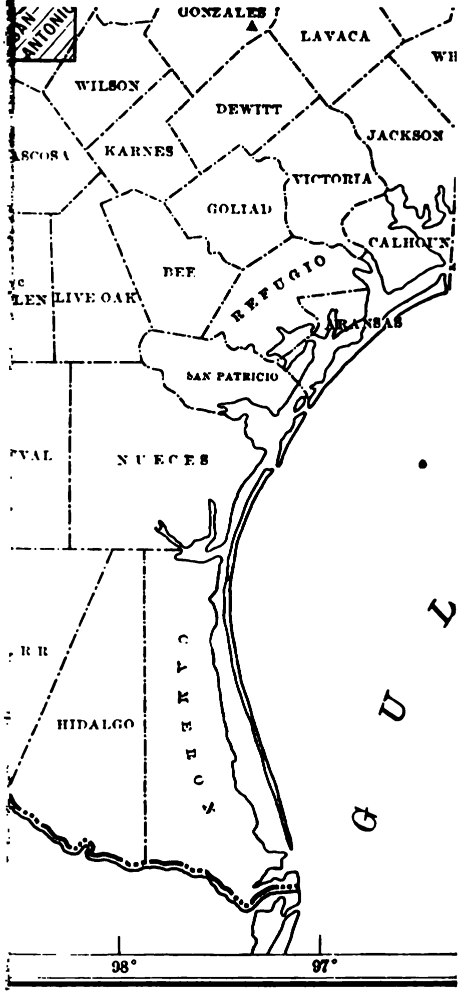

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scale of 1:62,500, with a contour interval of 20 feet, in connection with which 426 miles of traverse were run. For the control of this and adjoining areas 516 miles of levels were run and 157 permanent bench marks were established.

Oregon-Idaho.—Part of the topographic work in Oregon was carried on under an agreement between the Director of the United States Geological Survey and the State engineer, by which an appropriation of $2,500 by the State was met by an allotment of $3,000 from the Geological Survey for cooperative work. Under this agreement one party was engaged in mapping the Mitchell Butte quadrangle, in Malheur County, Oreg., and Canyon and Owyhee counties, Idaho, for publication on the scale of 1:125,000, with a contour interval of 50 feet. The area mapped was 759 square miles, of which 30 were in Idaho. This area was supplemented by 105 square miles previously mapped by the Reclamation Service, thus completing the quadrangle, namely, 864 square miles. For the control of this and adjoining areas 150 miles of levels were run, 35 permanent bench marks were established, and 1,097 miles of traverse were run.

South Dakota.—Topographic work was carried on by one party in South Dakota in the Indian quadrangle, the Redwater quadrangle, which was completed, and the Two Top quadrangle, all in Butte County. The total area surveyed was 329 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 1,009 miles of traverse were run.

Texas.—Topographic work was carried on by one party in the Texarkana quadrangle, in Cass County, for publication on the scale of 1:125,000, with a contour interval of 20 feet. The area mapped was 321 square miles, in connection with which 1,113 miles of traverse and 22 miles of levels were run and 4 permanent bench marks were established.

Utah.—Topographic work in Utah was carried on by two parties in the Iron Springs, Frisco, and Cottonwood Special quadrangles, the last two being completed. The Cottonwood Special, in Summit, Wasatch, Utah, and Salt Lake counties, was surveyed for publication on the scale of 2,000 feet to the inch, with a contour interval of 50 feet, the area mapped being 22 square miles. The Iron Springs Special, consisting of 204 square miles in Iron County, and the Frisco Special, consisting of 93 square miles in Beaver County, were surveyed for publication on the scale of 1:62,500, with a contour interval of 50 feet. In connection with this work 79 miles of levels were run, 18 permanent bench marks were established, and 698 miles of traverse were run.

Washington.—One topographic party completed the survey of the Blaine quadrangle, in Whatcom and San Juan counties. The area mapped was 191 square miles, for publication on the scale of 1:62,500.

with a contour interval of 20 feet, in connection with which 769 miles of traverse lines were run. A level party carried forward control for this quadrangle and adjoining areas, running 188 miles of levels and establishing 39 permanent bench marks.

Washington-Idaho.—One party was engaged in the completion of the Pullman quadrangle, in Whitman and Garfield counties, Wash., and Latah and Nez Perces counties, Idaho, for publication on the scale of 1:125,000, with a contour interval of 50 feet. The area mapped was 382 square miles, 68 square miles being in Idaho and 314 square miles in Washington.

FOREST RESERVES.

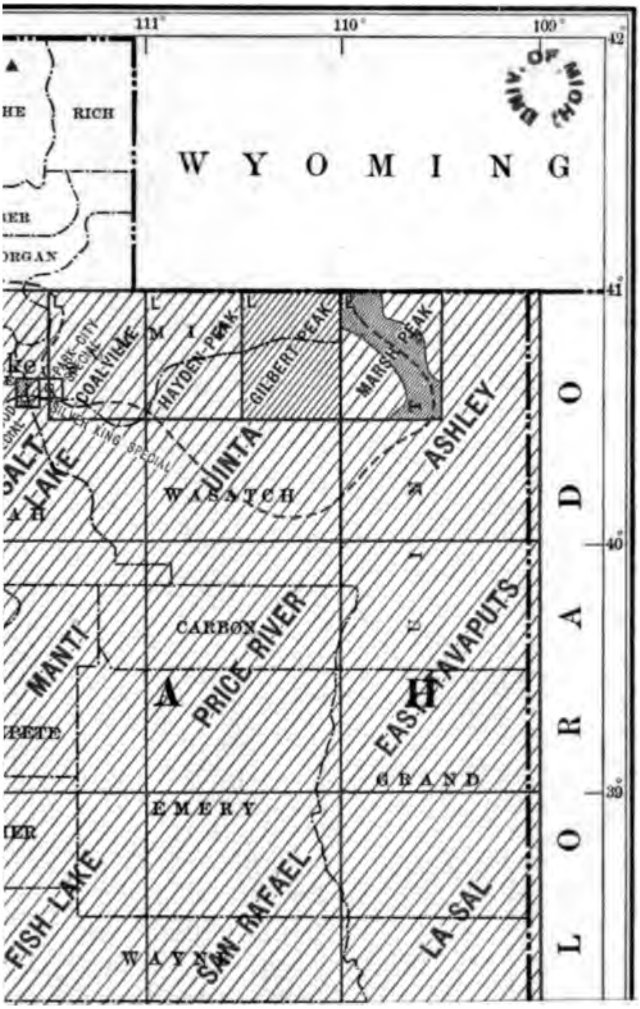
TOPOGRAPHIC SURVEYS OF FOREST RESERVES.

Arizona, Tonto Forest Reserve.—One party was engaged in the survey of parts of the Four Peaks and Livingston quadrangles, in Maricopa and Gila counties, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The area completed was 655 square miles, in connection with which 160 miles of traverse lines were run. For the control of this and adjoining areas 143 miles of levels were run and 44 permanent bench marks were established.

Arizona, Grand Canyon Reserve.—Another party completed the survey of the Shinumo quadrangle, consisting of 234 square miles in Coconino County, for publication on the scale of 1:48,000, with a contour interval of 50 feet. In connection with this mapping 432 miles of traverse were run; 28 miles of levels were also run, and 7 permanent bench marks were established. In addition, for the control of the Grand Canyon Reserve, one party carried a line of checked levels from Ash Fork nearly to Jerome Junction, the distance covered being 22 miles, in connection with which 8 permanent bench marks were established.

California, Sierra Reserve.—Two parties were engaged in the topographic survey of the Olancha and Mount Whitney quadrangles, in Tulare, Inyo, and Fresno counties. The area surveyed was 1,920 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 1,418 miles of traverse were run. For the control of these and adjoining areas 332 miles of levels were run, in connection with which 72 permanent bench marks were established. In addition, 238 miles of check levels were run.

California, Stanislaus Reserve.—One party was engaged in the topographic survey of the southwest quarter of the Bridgeport quadrangle, comprising an area of 265 square miles in Mono and Tuolumne counties, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In connection with this work 168 miles of traverse lines were run.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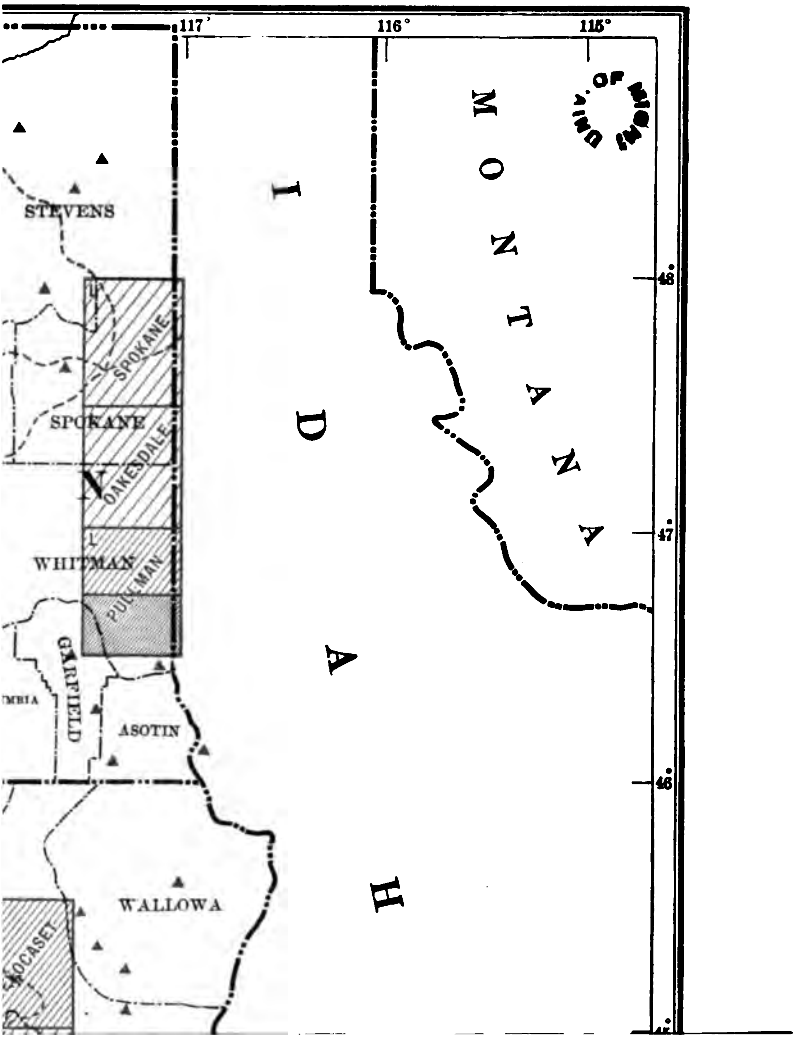

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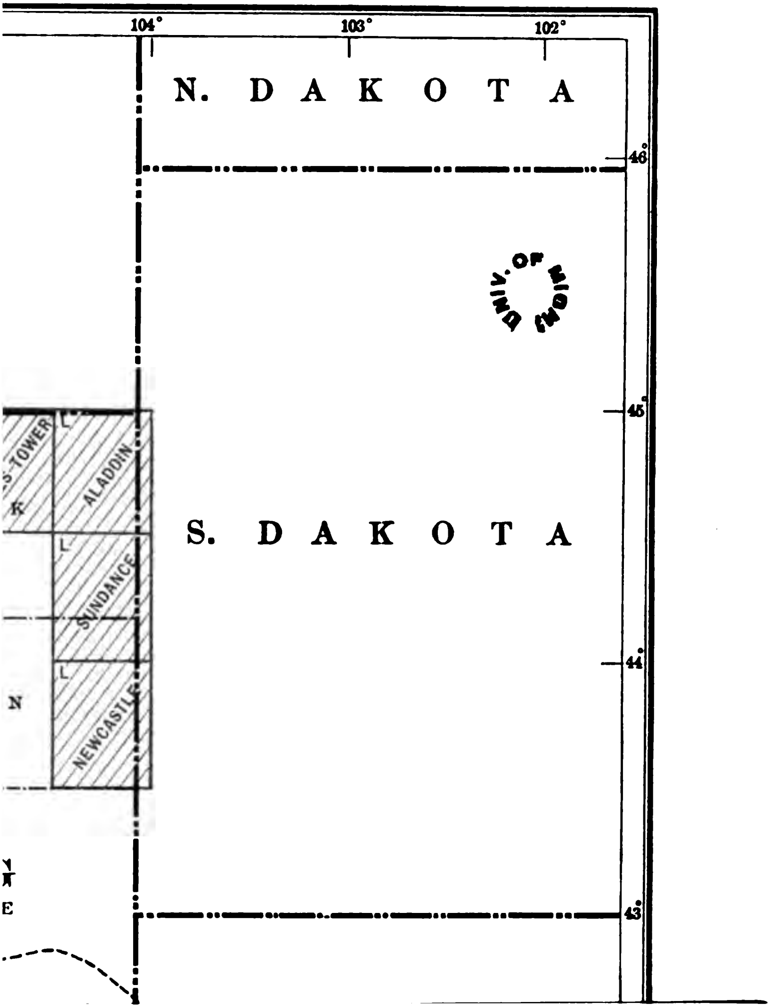
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California, Trinity Reserve.—For the control of this reserve 159 miles of levels were run, in connection with which 49 permanent bench marks were established.

Colorado, San Juan Reserve.—One party was engaged in the completion of the topographic survey of the San Cristobal quadrangle, in Hinsdale, Mineral, San Juan, and La Plata counties, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The area surveyed was 784 square miles, in connection with which 735 miles of traverse lines were run and 4 permanent bench marks were established by vertical angulation.

Idaho, proposed reserve.—One party was engaged in the topographic survey of the Cataldo quadrangle, in Kootenai and Shoshone counties. The area mapped was 160 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 195 miles of traverse lines were run. For the control of this quadrangle and adjoining areas 120 miles of levels were run and 19 permanent bench marks were established.

Idaho, Priest River Reserve.—One party secured partial control for this reserve by running 14 miles of levels and establishing 8 permanent bench marks.

Montana, Hellgate Reserve.—One party was engaged in the topographic survey of the Philipsburg quadrangle and of a small adjoining area in the Anaconda quadrangle, in Deerlodge and Granite counties. The area mapped was 856 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 615 miles of traverse lines were run. For the control of this work 216 miles of levels were run and 61 permanent bench marks were established.

New Mexico.—One party was engaged in running levels in two localities in New Mexico, in one for the control of a proposed reserve including the Gallina quadrangle, and in the other, which was along the Santa Fe Railway, for securing control for the Gila River Reserve. The total distance was 415 miles of levels, in connection with which 144 permanent bench marks were established.

Oregon, proposed reserves.—One party was engaged in the topographic survey of the Grants Pass quadrangle, in Jackson and Josephine counties, the area mapped being 885 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 320 miles of traverse were run. Another party was engaged in the topographic survey of part of the Ironside Mountain quadrangle, in Baker, Malheur, Grant, and Harvey counties, the area mapped being 541 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 584 miles of traverse were run. For the control of the Ironside Mountain and adjoining quadrangles 152 miles of levels were run, in connection with which 39 permanent bench marks were established. In addition, one party secured leveling control for the Susanville quadrangle, 87 miles being run and 26 permanent bench marks established. A line of check levels, consisting of 16 miles, was run in the Telocaset quadrangle.

Utah, Uinta Reserve.—One party was engaged in the resurvey of the Marsh Peak quadrangle, in Uinta County. The area mapped was 410 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In connection with this work 115 miles of levels were run, 31 permanent bench marks were established, and 391 miles of traverse were run. A resurvey of 16 square miles of the Gilbert Peak quadrangle, in Summit and Wasatch counties, was also made, in connection with which 120 miles of traverse were run.

Washington, Washington Reserve.—For the control of this reserve one party ran a line of 57 miles of levels and established 17 permanent bench marks.

Wyoming, Yellowstone Reserve.—One party was engaged in the topographic survey of the Younts Peak quadrangle, in Bighorn and Fremont counties. The area surveyed was 864 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 191 miles of traverse were run. For the control of this and adjoining areas 409 miles of levels were run and 153 permanent bench marks were established.

Wyoming, Medicine Bow Reserve.—One party was engaged in the survey of the Medicine Bow quadrangle, in Albany and Carbon counties, which was not finished. The area mapped was 234 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, in connection with which 433 miles of traverse were run.

BOUNDARY SURVEYS OF FOREST RESERVES.

California, Sierra and Stanislaus Reserves.—The survey of a portion of the boundaries of these reserves adjacent to the Yosemite National Park was commenced about the first of June, and work was continued until early in November, when 125 miles of lines were completed, 5 miles being retraced. In connection with this work, and according to instructions received from the Secretary of the Interior, a survey of the SW. ¼ NE. ¼ sec. 18, T. 2 S., R. 20 E., was made and certain corners in the same township and range were established. The latter work was carried on with funds supplied by the General Land Office.

California, Santa Barbara Reserve.—Work on the survey of the boundary of this reserve was in progress at the close of the last annual report and was continued until the middle of January, 1906, operations covered by this report beginning May 1. During the year 184 miles of boundary were surveyed and marked with 406 iron posts, in connection with which 11 miles of supplemental lines and 7 miles of retracement lines were surveyed.

Utah, Logan Forest Reserve.—Between June 3 and 18 corrections were made of certain portions of the boundary established the previous year.

Utah, Payson Forest Reserve.—Work on the boundary of this reserve, which was begun the previous year, was completed about July 22, when 18 miles of line had been run and marked with 22 iron posts and 4 miles of supplemental line.

OFFICE DRAFTING.

Arizona.—The drafting of the Sacaton sheet was completed, for engraving on the scale of 1:62,500, with a contour interval of 50 feet, and 80 per cent of the Shinumo sheet was completed, on the scale of 1:48,000. About 70 per cent of the drafting of the Four Peaks and 1 per cent of the drafting of the Livingston sheets were also completed, on the scale of 1:125,000, with a contour interval of 100 feet.

California.—The drafting of the following sheets was completed: Colusa, Davisville, Dunnegan, and Woodland, for engraving on the scale of 1:62,500, with a contour interval of 10 feet; Tesla, for engraving on the scale of 1:62,500, with a contour interval of 20 feet; Holtville, Mount Whitney, and Olancha, for engraving on the scale of 1:125,000, with a contour interval of 20 feet for the Holtville and 100 for the Mount Whitney and Olancha. The drafting of the Salton Sink reconnaissance map was completed, for engraving on the scale of 1:500,000, with a contour interval of 50 feet. About 60 per cent of the drafting of the Yosemite Special sheet was completed, on the scale of 1:24,000, with a contour interval of 100 feet; 30 per cent of the Bridgeport, on the scale of 1:125,000, with a contour interval of 100 feet, and about 15 per cent of the Knights Landing, 10 per cent of the Rumsey and Capay, and 40 per cent of the Grimes, all on the scale of 1:62,500, with a contour interval of 100 feet.

Colorado.—The drafting of the Mount Olympus and San Cristobal sheets was completed and about 50 per cent of the Loveland and Fort Collins sheets. The Mount Olympus sheet is being engraved on the scale of 1:62,500 and the San Cristobal on the scale of 1:125,000, both having a contour interval of 100 feet.

Montana.—The drafting of the Philipsburg sheet was completed and about 1 per cent of the drafting of the Anaconda, both for engraving on the scale of 1:125,000, with a contour interval of 100 feet.

Nevada.—The drafting of the Bullfrog and Goldfield specials was completed, both for engraving on the scale of 1:24,000, with a contour interval of 20 feet.

Nevada-California.—The drafting of the reconnaissance map of the Amargosa region was completed and has been engraved on the scale of 1:250,000, with a contour interval of 100 feet.

Oklahoma.—The drafting of the Chandler sheet was completed, for engraving on the scale of 1:62,500, with a contour interval of 20 feet; also about 15 per cent each of the Agra and Mallon and 20 per cent of the Sac and Fox sheets on the same scale and with the same contour interval.

Oregon.—The drafting of the Grants Pass sheet was completed and about 60 per cent of that of the Ironside Mountain sheet, both on the scale of 1:125,000, with a contour interval of 100 feet.

Oregon-Idaho.—The final drafting of the Mitchell Butte sheet was completed, for engraving on the scale of 1:125,000, with a contour interval of 50 feet.

South Dakota.—The drafting of the Indian and Redwater sheets was completed, for engraving on the scale of 1:62,500, with a contour interval of 20 feet; and about 50 per cent of the Two Top, on the same scale and with the same contour interval; also the manuscript was prepared for the Belle Fourche sheet, for publication on the scale of 1:125,000, with a 50-foot contour interval.

Texas.—About 33 per cent of the drafting of the Texarkana sheet was completed, on the scale of 1:125,000, with a contour interval of 20 feet.

Utah.—The drafting of the Frisco and Iron Springs specials was completed, for engraving on the scale of 1:62,500, with a contour interval of 50 feet; also of the Cottonwood special, for engraving on the scale of 1:24,000, with a contour interval of 50 feet, and of the Gilbert Peak sheet, for engraving on the scale of 1:125,000, with a contour interval of 100 feet. About 50 per cent of the Marsh Peak sheet was completed, on the scale of 1:125,000, with a contour interval of 100 feet.

Washington.—The drafting of the Blaine sheet was completed, for engraving on the scale of 1:62,500, with a contour interval of 20 feet.

Washington-Idaho.—The drafting of the Pullman sheet was completed, for engraving on the scale of 1:125,000, with a contour interval of 50 feet.

Wyoming.—The drafting of the Younts Peak sheet was completed, for engraving on the scale of 1:125,000, with a contour interval of 100 feet; and 95 per cent of the Medicine Bow sheet was completed, on the same scale and with the same contour interval.

Forest-reserve boundaries.—The drafting of the plat of the boundary of the Logan Forest Reserve, Utah, was completed, in connection with which 5 subdivision plats were made.

The drafting of the plat of the boundary of the Payson Forest

Reserve, Utah, was completed, in connection with which 6 subdivision plats were made.

The drafting of about 50 per cent of the plat of the exterior boundary of the Yosemite National Park, California, which is also part of the boundaries of the Sierra and Stanislaus forest reserves, was completed, in connection with which 2 subdivision plats were made.

Triplicate copies of about 500 pages of forest reserve boundary notes were typewritten.

TRIANGULATION AND COMPUTING SECTION.

FIELD WORK.

EASTERN DIVISION.

Primary triangulation, primary traverse, and precise leveling were carried on at various times by seven parties. This work was distributed over portions of 18 States—Alabama, Arkansas, Iowa, Indiana, Kentucky, Louisiana, Maine, Missouri, Illinois, Michigan, Nebraska, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, West Virginia, and Wisconsin. The total area covered by this primary control was 19,130 square miles, of which 17,315 square miles were controlled by primary traverse. The result of this control was to make available seventy-four 15-minute quadrangles and three 30-minute quadrangles in which to prosecute future topographic surveys. In the progress of this work 38 triangulation stations were permanently marked and their geodetic positions determined, and 3,261 miles of primary traverse were run.

Alabama.—Additional control for the Opelika 30-minute quadrangle, in Chambers and Lee counties, was obtained by 78 miles of primary traverse.

Arkansas.—The Fort Smith 30-minute quadrangle, covering portions of the counties of Crawford and Sebastian, was controlled by 141 miles of primary traverse, so distributed as to furnish control for four 15-minute quadrangles, into which the original 30-minute quadrangle will be subdivided.

Georgia.—The Talbotton 30-minute quadrangle, in Harris, Meriwether, Muscogee, and Talbot counties, was controlled by 122 miles of primary traverse. The Dahlonega special quadrangle, in Lumpkin County, was controlled by 48 miles of primary traverse.

Illinois.—Control for the Belleville, Breeze, Mahomet, Springfield, Tallula, Urbana, and Wheaton quadrangles, in the counties of Champaign, Clinton, Dupage, Madison, Menard, and Sangamon, was secured by 403 miles of primary traverse. A line of precise levels, 87 miles in length, was run in the fall of 1905 from Pekin along the Peoria and Eastern Railway to Champaign.

Indiana.—Portions of the New Albany, Prospect, and River View quadrangles, in the counties of Clark, Floyd, and Harrison, were controlled by 97 miles of primary traverse.

Iowa-Nebraska.—The Nebraska City quadrangle, covering portions of Fremont County, Iowa, and Otoe County, Nebr., was controlled by 68 miles of primary traverse, of which 50 miles are in Nebraska and 18 miles in Iowa. A line of precise levels, 142 miles in length, was run from Council Bluffs to Des Moines, Iowa.

Kentucky.—In Bullitt, Jefferson, Shelby, and Spencer counties 76 miles of primary traverse were run for the control of the Shelbyville and Taylorsville quadrangles.

Louisiana.—The Baton Rouge, Grossetete, and Whitecastle quadrangles, covering portions of Ascension, Berryville, and East Baton Rouge parishes, were controlled by 134 miles of primary traverse.

Maine.—The Lewiston and Poland quadrangles, in Androscoggin and Oxford counties, were controlled by means of 6 occupied and 8 intersected triangulation stations.

Michigan.—The Howell, Leonard, Milford, Pontiac, and Rochester quadrangles, in Lapeer, Livingston, and Oakland counties, were controlled by 201 miles of primary traverse.

Mississippi.—The Jackson, Florence, Raymond, and Terry 15-minute quadrangles, in Copiah, Hinds, Madison, and Rankin counties, were controlled by 149 miles of primary traverse.

Missouri.—The Atlanta, Macon, Shelbyville, and Shelbina quadrangles, in Macon, Monroe, and Randolph counties, were controlled by 137 miles of primary traverse.

North Carolina.—The Beckford, Winton, Four Oaks, Salemburg, Charlotte, and Matthews 15-minute quadrangles, in the counties of Bertie, Cabarrus, Gates, Hertford, Mecklenburg, Pasquotank, Johnston, and Sampson, were controlled by 410 miles of primary traverse. During the season of 1905 two lines of precise levels were run; the first from Durham along the Southern Railway northward to the Virginia State line, a distance of 50 miles; the second from Greensboro along the Southern Railway to Madison, thence along the Norfolk and Western Railway to the Virginia State line near Price, a distance of 42 miles.

Ohio.—Primary-traverse control was carried on in two areas. In the northwestern portion of the State, in the counties of Defiance, Fulton, Henry, Williams, Lucas, and Wood, nine quadrangles were controlled by 289 miles of primary traverse; and in the central portion of the State, in the counties of Coshocton, Fairfield, Licking, Muskingum, and Perry, eight quadrangles were controlled by 369 miles of traverse. A line of precise levels was run along the Norfolk and Western Railway from Chillicothe to Columbus, a distance of 52 miles.

Pennsylvania.—In Warren County two 15-minute quadrangles were controlled by locating 10 triangulation stations. In Berks, Lancaster, and York counties three quadrangles were controlled by 179 miles of primary traverse.

South Carolina.—The Sharon and Rockhill quadrangles, in the counties of Chester and York, were controlled by 139 miles of primary traverse.

Virginia.—The lines of precise levels previously mentioned under the heading of North Carolina were extended into Virginia—the first line to Clarksville, a distance of 6 miles, and the second line from Price to Buchanan, a distance of 100 miles.

West Virginia.—A reconnaissance triangulation was extended over the Horton and Elkins quadrangles, in Randolph and Tucker counties; signals were erected on 9 stations, and observations completed at 4 of them.

Wisconsin.—The La Crosse and Sparta quadrangles, in Monroe County, were controlled by 8 triangulation stations. The Cross Plains, Clyman, Delavan, Hartford, Janesville, Shopiere, Port Washington, Waukesha, and West Bend quadrangles, in Dodge, Iowa, Madison, Monroe, Milwaukee, Ozaukee, Rock, Walworth, and Washington counties, were controlled by 221 miles of primary traverse.

WESTERN DIVISION.

Triangulation was carried on at various times during the year by eleven parties and primary traverse by one party. This work was distributed over portions of eight States and Territories—California, Montana, New Mexico, Oklahoma, Oregon, Utah, Washington, and Wyoming. The total area covered by this primary control was 32,300 square miles, of which 400 square miles were controlled by primary traverse. The result of this control was to make available five 15-minute quadrangles, twenty-four 30-minute quadrangles, and seven special maps in which to prosecute future surveys. In the progress of this work 290 new triangulation stations were selected, permanently marked, and their geodetic positions determined, and 63 miles of primary traverse were run.

California.—Four 15-minute quadrangles, in the counties of Colusa, Sacramento, and Yolo, were controlled by 63 miles of primary traverse, and the Yosemite Special quadrangle, in Mariposa County, was controlled by locating 10 triangulation stations.

Montana.—Portions of three quadrangles, in Fergus County, were controlled by occupying 9 triangulation stations and locating 12 points by intersections.

Nevada-California.—Control for the Amargosa Special map, covering an area of 7,000 square miles in Inyo County, Cal., and Esmeralda and Nye counties, Nev., was secured by two triangulation parties; 18 stations were occupied and 7 points were located by intersections.

Oklahoma.—Five quadrangles, in Lincoln, Logan, Pawnee, and Payne counties, were controlled by one triangulation party, which occupied 20 new stations and located 20 points by intersections.

Utah.—An area of 1,000 square miles, including the Iron Springs Special quadrangle, in Beaver and Iron counties, was controlled by the location of 7 triangulation stations.

Washington.—Triangulation control for portions of four quadrangles, in Skagit and Whatcom counties, was secured by one party, which occupied 17 new stations and located 15 additional points by intersections.

TRIANGULATION OF FOREST RESERVES.

California, Sierra Reserve.—Triangulation control for this reserve was completed by the occupation of 17 primary stations and the location by intersection of 16 secondary points by one party. Another party located 5 triangulation stations for the control of the Bridgeport quadrangle, in Mono County.

California, Trinity Reserve.—Four 30-minute quadrangles, in Del Norte and Siskiyou counties, were controlled by 15 triangulation stations.

Idaho, Priest River Reserve.—Triangulation control for an area of 800 square miles in Kootenai County was partly completed by the occupation of 3 old and 2 new stations.

Montana, Hellgate Reserve.—An area of 1,200 square miles in Granite and Ravalli counties was controlled by occupying 9 new stations and locating 25 points by intersections.

New Mexico, proposed reserves.—One 30-minute quadrangle in Rio Arriba County was partly controlled by one party, which occupied 10 triangulation stations and located several points by intersections. An area of 1,000 square miles in Socorro County was triangulated by another party, which occupied 5 new stations and located 6 points by intersections.

Wyoming, Yellowstone Reserve.—An area of 4,500 square miles in Bighorn, Fremont, and Natrona counties was controlled by one triangulation party, which selected, occupied, and monumented 25 new stations and located 13 secondary points.

OFFICE WORK.

The office computation of triangulation, primary traverse, and adjustment of level circuits was carried on in this section as heretofore. The results of primary triangulation and primary traverse in 26 States were summarized and published in Bulletin No. 276.

The results for spirit leveling in the State of New York for the years 1896–1905, inclusive, were published in Bulletin No. 281; and the results of leveling in Pennsylvania for the years 1899–1905, inclusive, were published in Bulletin No. 288. The triangulation and leveling plats of all States were brought up to date, as well as the card catalog of triangulation and primary traverse stations. The preparation of triangulation and leveling data for chiefs of field parties and in reply to requests of persons not connected with the Survey required the time of a considerable portion of the office force.

During the year the following results were computed:

EASTERN DIVISION.

Alabama.—For the control of the Opelika 30-minute quadrangle, in Chambers and Lee counties, 623 latitudes and departures and 58 geographic positions were computed. Level circuits in the Birmingham and Leeds quadrangles, in Jefferson County, were adjusted.

Arkansas.—In the Fort Smith quadrangle, in Crawford and Sebastian counties, 691 latitudes and departures and 117 geographic positions were computed. Level circuits in the Harrison quadrangle, in Boone and Carroll counties, were adjusted.

Delaware.—The results of leveling in Kent, Newcastle, and Sussex counties were revised and rearranged.

Georgia.—For the Dahlonega quadrangle, in Lumpkin County, 831 latitudes and departures and 40 geographic positions were computed. In the Talbotton quadrangle, in Harris, Meriwether, Muscogee, and Talbot counties, 993 latitudes and departures and 99 geographic positions were computed. Level circuits in the Griffin and Talbotton quadrangles were also adjusted.

Illinois.—For the Springfield, Tallula, Urbana, Mahomet, Belleville, Breese, and Wheaton quadrangles, in Champaign, Clinton, Dupage, Madison, Menard, and Sangamon counties, 1,411 latitudes and departures and 336 geographic positions were computed. Level circuits in the Breese, Belleville, Eldorado, Mahomet, New Haven, Springfield, and Urbana quadrangles, in Champaign, Clinton, Gallatin, Madison, Menard, Sangamon, Saline, and White counties, were adjusted, and the office computation of the precise line from Pekin to Champaign was made.

Indiana.—For the New Albany, Prospect, and River View quadrangles, in Clark, Floyd, and Harrison counties, 758 latitudes and departures and 80 geographic positions were computed.

Iowa.—Level circuits in the Des Moines quadrangle, in Polk County, were adjusted, and office computation of the precise line from Council Bluffs to Des Moines was completed. For the portion of the Nebraska City quadrangle lying within Fremont County, Iowa, 60 latitudes and departures and 10 geographic positions were computed.

Kentucky.—For the Shelbyville and Taylorsville quadrangles, in Bullitt, Jefferson, and Oldham counties, 654 latitudes and departures and 66 geographic positions were computed. Level circuits in the Calhoun, Pineville, Sebree, and Sutherland quadrangles, in Bell, Daviess, and McLean counties, were adjusted.

Louisiana.—For the Baton Rouge, Grossetete, and Whitecastle quadrangles, in Ascension, Iberville, and East Baton Rouge parishes, 656 latitudes and departures and 135 geographic positions were computed. Level circuits in the Baton Rouge quadrangle were adjusted.

Maine.—The geodetic positions of 11 triangulation stations for the control of the Lewiston and Poland quadrangles, in Androscoggin and Oxford counties, were computed.

Maryland.—Results of leveling in Baltimore, Caroline, Cecil, Dorchester, Harford, Queen Anne, Talbot, Somerset, Wicomico, and Worcester counties were revised and rearranged for publication.

Michigan.—For the Howell, Leonard, Milford, Pontiac, and Rochester quadrangles, in Lapeer, Livingston, and Oakland counties, 720 latitudes and departures and 178 geographic positions were computed. The level circuits in the Marquette quadrangle, in Marquette County, were adjusted.

Minnesota.—Level circuits in the Lake Minnetonka quadrangle, in Carver, Hennepin, and Wright counties, were adjusted.

Mississippi.—For the Florence, Jackson, Raymond, and Terry quadrangles, in Copiah, Hinds, Madison, and Rankin counties, 1,542 latitudes and departures and 132 geographic positions were computed and level circuits in the same area were adjusted.

Missouri.—For the Atlanta, Macon, Shelbina, and Shelbyville quadrangles, in Macon, Monroe, and Randolph counties, 520 latitudes and departures and 137 geographic positions were computed and level circuits in portions of the same area were adjusted.

Nebraska.—For the Nebraska City quadrangle, in Otoe County, 200 latitudes and departures and 43 geographic positions were computed and levels in the same area were adjusted.

New Hampshire.—Level circuits in the Claremont, Hanover, and Sunapee quadrangles, in Grafton and Sullivan counties, were adjusted.

North Carolina.—For the Beckford, Charlotte, Four Oaks, Matthews, Salemburg, and Winton quadrangles, in Bertie, Cabarrus, Gates, Hertford, Johnston, Pasquotank, and Sampson counties, 2,605 latitudes and departures and 323 geographic positions were computed. Level circuits were adjusted in the Beckford, Dunn, Four Oaks, and Winton quadrangles; and office reductions were made of precise lines from Durham north to State line and from Greensboro to Price.

North Dakota.—Level circuits in the Bismarck 30-minute quadrangle, in Burleigh and Morton counties, were adjusted.

Ohio.—For 17 quadrangles in the counties of Coshocton, Defiance, Fairfield, Fulton, Henry, Lucas, Licking, Muskingum, Perry, Williams, and Wood 2,828 latitudes and departures and 650 geographic positions were computed. Level circuits were adjusted in the following counties: Ashtabula, Crawford, Clinton, Clark, Darke, Gallia, Greene, Hamilton, Huron, Madison, Miami, Montgomery, Pickaway, Portage, Preble, Putnam, Ross, Sandusky, Trumbull, and Wyandot. The office reduction of the precise-level line Chillicothe to Columbus was made.

Pennsylvania.—The geodetic coordinates of 10 triangulation stations in the Warren and Youngsville quadrangles, in Warren County, and 1,061 latitudes and departures and 152 geographic positions in the New Cumberland, New Holland, and Middletown quadrangles, in Berks, Lancaster, and York counties, were computed. Levels in the same areas were adjusted and prepared for publication, together with the results of spirit leveling in the rest of the State.

South Carolina.—For the Sharon and Rockhill quadrangles, in Chester and York counties, 990 latitudes and departures and 106 geographic positions were computed and level circuits in the same area were adjusted.

Tennessee.—Level circuits for the Maynardsville and Pineville quadrangles, in Claiborne and Hancock counties, were adjusted.

Virginia.—The geodetic positions of 8 triangulation stations in the Stuart quadrangle, in Floyd and Patrick counties, were computed; level circuits in the Buchanan quadrangle were adjusted, and office computation of precise-level lines near Clarksville and from Price to Buchanan was made.

West Virginia.—The preliminary computation of triangulation in the Horton and Elkins quadrangles, in Randolph and Tucker counties, was made, and level circuits in the Glenwood, Point Pleasant, Ravenswood, Ripley, Spencer, and Thornton quadrangles, in Calhoun, Jackson, Mason, Wood, and Wirt counties, were adjusted. The lists of levels thruout the State were also revised and rearranged for publication.

Wisconsin.—The geodetic positions of 6 triangulation stations in the La Crosse and Sparta quadrangles, in Monroe County, were computed and also 760 latitudes and departures and 174 geographic positions in eight quadrangles in Dodge, Iowa, Madison, Milwaukee, Ozaukee, Rock, Shopiere, Walworth, and Washington counties. Level circuits in the Cross Plains, Denzer, La Crosse, Mazomanie, Richland Center, Sparta, and Sun Prairie quadrangles, in Dane, Iowa, La Crosse, Monroe, Richland, and Sauk counties, were adjusted.

WESTERN DIVISION.

Arizona.—Level circuits in the Four Peaks and Globe quadrangles, in Gila and Maricopa counties, were adjusted, and the office reduction of the precise-level line in Yuma, Maricopa, and Pinal counties was completed.

California.—The following groups of level circuits were adjusted: The Imperial project, in San Diego County; the Sonoma and Yosemite quadrangles, in Mariposa County; the Freeman, Keeler, Mount Whitney, and Tehipite quadrangles, in Fresno, Inyo, and Kaweah counties, and the special maps in the Sacramento Valley. The office computation of the precise line from Mohave to Laws and from Alvord to Lida was completed. Results of primary traverse and triangulation were computed at the suboffice at Sacramento as follows: 370 latitudes and departures and 58 geographic positions in Colusa, Sacramento, and Yolo counties for 4 special sheets. The geodetic coordinates of 15 triangulation stations in Del Norte and Siskiyou counties, the geodetic coordinates of 10 triangulation stations in Mariposa County for the Yosemite Special map, 5 geodetic coordinates in the Bridgeport quadrangle, in Mono County, and the geodetic coordinates of 33 triangulation stations in seven 30-minute quadrangles in Inyo and Mono counties were computed.

Colorado.—Level circuits in the Fort Collins, Livermore, and Mount Olympus quadrangles, in Larimer County, were adjusted.

Idaho.—The positions of 5 triangulation points in Kootenai County were computed and level circuits in the Cataldo and Sand Point quadrangles in Kootenai and Shoshone counties were adjusted.

Montana.—The geodetic positions of 21 triangulation stations in Fergus County and of 34 stations in Granite and Ravalli counties were computed. Level circuits were adjusted in quadrangles in Boulder, Deerlodge, Granite, Powell, and Silverbow counties.

Nevada.—The geodetic positions of 20 triangulation stations in Esmeralda and Nye counties were computed, and level circuits in the same area were adjusted.

New Mexico.—The geodetic coordinates of 22 triangulation stations in Rio Arriba and Socorro counties were computed and level circuits in one 30-minute quadrangle in Rio Arriba County were adjusted. A computation was made of the precise line of levels thru Valencia, Socorro, Sierra, Donna Ana, Luna, and Grant counties.

Oklahoma.—The triangulation for five quadrangles in Lincoln, Logan, Pawnee, and Payne counties was adjusted by least squares, and the geodetic coordinates of 40 stations were computed. The level circuits within the same area were adjusted.

Oregon.—Level circuits in the Ironside Mountain, Mitchell Butte, Susanville, and Telocaset quadrangles, in Baker, Grant, Malheur, and Union counties, were adjusted.

Texas.—The results of leveling in seven 30-minute quadrangles in Bexar, Burnett, Bastrop, Caldwell, Fayette, Gonzales, Gillespie, Medina, and Uvalde counties were revised and rearranged for publication.

Utah.—The geodetic coordinates of 7 triangulation stations in Beaver and Iron counties were computed.

Washington.—The geodetic coordinates of 32 triangulation stations in four 30-minute quadrangles in Skagit and Whatcom counties were computed and level circuits in two quadrangles in the same counties were adjusted.

Wyoming.—Least-square adjustment of triangulation in Fremont, Bighorn, and Natrona counties was made and geodetic coordinates of 25 triangulation stations were computed. Levels in five 30-minute quadrangles in the same counties were adjusted.

SECTION OF INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

During the field season inspection of topographic mapping, completed or in progress, was carried on in various parts of the United States for the purpose of maintaining a uniformity of style and system in the expression of topographic features. Localities visited were as follows: Rockland, Me.; Ogdensburg, Depew, and Angelica, N. Y.; Duncannon, Johnstown, and Punxsutawney, Pa.; Mount Sterling, Ohio; Elizabeth, W. Va.; Denton and Barclay, Md.; Highland, N. C.; Campobello, S. C.; Columbus and Washington, Ga.; Birmingham, Ala.; Jackson, Miss.; Baton Rouge and Bayou Sara, La.; Sebree and Sutherland, Ky.; Chandler, Okla.; Belle Fourche, S. Dak.; Kirwin and Laramie, Wyo.; Philipsburg, Mont.; Cedar City, Utah; Creede, Colo.; Socorro, N. Mex.; Phoenix, Mesa, and Tombstone, Ariz.

During the office season careful attention was given to the final drawing of map sheets for the elimination of personal mannerisms and minor errors of expression, and the preparation and final drawing of new material for revision of the base map of the United States was continued in the office during the year.

SECTION OF INSTRUMENTS AND TOPOGRAPHIC RECORDS.

The systematic overhauling of all instruments was continued, the work being done in the shop of the Survey except in cases requiring extensive repairs, when the articles were sent to the makers. Purchases were made from time to time to cover losses occasioned by wear and tear. Except for a few levels of the Coast Survey type and a few telescopic alidades fitted with the special stadia attachment, no extensive purchases were made. The special purchases were made in order that the experimentations begun the previous year might be continued.

The filing of the original records under the existing card system was continued. The number of pieces filed was about 1,900, comprising triangulation, level, and topographic notebooks and plane-table sheets. In addition about 100 pieces of miscellaneous material were catalogued and filed.

DIVISION OF GEOGRAPHY, AND FORESTRY.

The preparation of a fourth edition of the Dictionary of Altitudes was completed, and it was published early in the autumn as Bulletin No. 274. A Gazetteer of Colorado was undertaken early in the year, and it has been completed and published as Bulletin No. 291. Gazetteers of New York and California were undertaken and are well advanced.

An outline map of North America, on a scale of 1:5,000,000, was undertaken and completed, and is now engraved. The revision of the three-sheet map of the United States, on a scale of 1:2,500,000, is well advanced. All the atlas sheets published by the Survey have been reduced and are ready for the engraver. On the unsurveyed areas the county lines and railroads have been revised and are also ready for engraving. The preparation of a map in sheets on a scale of 1:1,000,000 has progressed rapidly, but as the work has been going on in various parts of the country it is difficult to measure the progress. Several sheets are complete and ready for the engraver.

The geographer in charge of the division was occupied mainly with the following duties:

Assisting the Forest Service, particularly in matters relating to geography and topography and in the organization of its reserve force.

His work as chairman of the Board on Geographic Names took considerable time, especially after the Presidential order of January 23, 1906, which extended materially the powers of the Board.

Much time was devoted to assisting the committee on Department methods, first in the investigation of the Bureau of Statistics of the Department of Agriculture, and second in the investigation in the Departments and bureaus of the Government of the organization for carrying on scientific and routine processes.

The editing of the report of the Eighth International Geographic Congress, published by the Public Printer, required considerable time during the first three months of the year.

For several years the Census Office and the Land Office have been publishing areas of States which differ from one another, and the Survey geographer, in cooperation with representatives of those two bureaus, is bringing these figures into accord. This work is well advanced.

HYDROGRAPHIC BRANCH.

ORGANIZATION.

The work of the hydrographic branch was divided into three parts—hydrography, hydrology, and hydro-economics—each composing a division. The division of hydrography has to do with the distribution of the surface waters of the United States; it determines the quantity and fluctuations of the flow of rivers, mainly those having importance for water power, irrigation, municipal supplies, or other industrial purposes. The division of hydrology investigates the currents of water under ground, particularly those reached by deep wells; and it is studying the geology of the earth's surface in so far as it concerns the distribution and amount of underground water, especially that having industrial importance. The division of hydro-economics studies the qualities of water as affecting its industrial and municipal uses.

DIVISION OF HYDROGRAPHY.

LOCAL OFFICES.

The field work of the division of hydrography was supervised thru several local offices, each office being in charge of a hydrographer who was responsible for the work of his district. These districts and offices were as follows:

Hydrographic districts and offices.

District.	Office.
New England	6 Beacon street, Boston, Mass.
New York	75 Arcade, Utica, N. Y.
Middle Atlantic States	Washington, D. C.
South Atlantic and Gulf States	409 Temple court, Atlanta, Ga.
Mississippi Valley	876 Federal Building, Chicago, Ill.
Montana district (Montana, North Dakota, and northern Wyoming).	Billings, Mont.
South Dakota	Bellefourche, S. Dak.
Denver district (Colorado, Kansas, Nebraska, and southern Wyoming).	Chamber of Commerce Building, Denver, Colo.
New Mexico district (New Mexico, Oklahoma, and Indian Territory).	Carlsbad, N. Mex.
Texas	Austin, Tex.
Arizona	Phoenix, Ariz.
Utah	Salt Lake City, Utah.
Nevada	Carson, Nev.
Idaho	Sonna Building, Boise, Idaho.
Oregon district (Oregon and Washington)	351 Washington street, Portland, Oreg.
California	1108 Union Trust Building, Los Angeles, Cal.

STREAM GAGING.

The work of the division of hydrography continued along lines previously developed. River stations for obtaining records of stage and discharge were maintained in all sections of the country. The locations of the principal river stations maintained during the year are given in the following list and are shown on Pl. XXIV.

Gaging stations, by States, maintained during fiscal year 1905–6.

River.	Station.
ALABAMA.	
Alabama	Selma.
Black Warrior	Cordova.
Black Warrior	Tuscaloosa.
Black Warrior (Locust Fork).	Palos.
Cahaba	Centerville.
Choccolocco	Jenifer.
Choctawhatchee	Elba Junction.
Clear Creek	Elk.
Conecuh	Beck.
Coosa	Riverside.
Elk	Elkmont.
Pea	Elba.
Pea	Pera.
Tallapoosa	Sturdevant.
Tombigbee	Epes.
ARIZONA.	
Chevelon Fork	Winslow.
Clear Creek	Winslow.
Colorado	Hardyville.
Colorado	Yuma.
Colorado (Little)	Holbrook.
Colorado (Little)	St. Johns.
Colorado (Little)	Woodruff.
Gila	Dome (Gila City).
Gila	San Carlos.
Salt	McDowell.
Salt	Roosevelt.
San Pedro	Charleston.
Santa Cruz	Tucson.
Silver Creek	Canyon, Snowflake.
Silver Creek	Snowflake.
Verde	McDowell.
ARKANSAS.	
Ouachita	Arkadelphia.
Ouachita	Malvern.
CALIFORNIA.	
Alamo	Rockwood.
Alamitos Canal	Calexico.
American	Fairoaks.
Arroyo Seco	Soledad.
Ash Creek	Adin.
Bear	Wheatland.
Big Pine Creek	Big Pine.
Big Pine and Owens River Canal	Bishop.
Birch Creek	Tinemaha.
Bishop Creek	Bishop.
Bishop Creek Canal	Bishop.
Boundary Canal	Calexico.
Cache Creek	Lower Lake.
Cache Creek	Yolo.
Chino Creek	Rincon.
Collins (Geo.) Canal	Bishop.
Collins (A. O.) Canal	Bishop.
Cottonwood Creek	Jamul.
Dell Creek	Bishop.
Donner Creek	Truckee.
East Side Canal	Citrus.
Farmers Canal	Bishop.
Feather	Oroville.
Feather	Prattville.
Hemlock Canal	Calexico.
Grizzly Creek	Beckwith.
Hillside Canal, north	Bishop.
Hillside Canal, south	Bishop.
Holt Canal	Calexico.
Holt Canal, new	Calexico.
Imperial Canal	Yuma.
Independence Creek	Hobart Mills.
Independence Creek	Independence.
Indian Creek	Crescent Mills.
Kaweah	Three Rivers.
Kern	Bakersfield.
Kings	Sanger.
CALIFORNIA—continued.	
Little Truckee	Boca (Pine Station).
Los Angeles	Los Angeles.
Lost	Clear Lake.
McCloud	Gregory (Baird).
Main Canal	Calexico.
McNalley Canal	Bishop.
Malibu Creek	Calabasas.
Merced	Merced Falls.
Merced	Yosemite Valley.
Modesto Canal	Lagrange.
Mohave	Victorville.
Mokelumne	Clements.
New	Calexico.
Oak Creek	Independence.
Owens.	Round Valley (Bishop).
Owens	Citrus (Independence).
Owens River Canal	Bishop.
Pine Creek	Round Valley (Bishop).
Pine Creek	Jamul.
Pit	Bieber.
Pit	Canby.
Powers Canal	Bishop.
Prosser Creek	Hobart Mills.
Puta Creek	Guenoc (Middletown)
Puta Creek	Winters.
Rawson Canal	Bishop.
Rock Creek	Round Valley (Bishop).
Sacramento	Red Bluff.
Sacramento	Sacramento.
Salton Lake	Mecca.
San Diego	Lakeside.
San Gabriel	Azuza.
Sanger Canal	Alvord.
San Joaquin	Herndon.
San Luis Rey	Pala.
Santa Ana	Mentone (Warm Springs).
Santa Ana	Rincon.
Santa Maria	Santa Maria.
Santa Ynez	Santa Barbara.
Santa Ysabel	San Pasqual Valley.
Stanislaus	Knights Ferry.
Stanislaus Water Company's Canal.	Knights Ferry.
Stevens Canal	Citrus.
Stony Creek	Fruto.
Susan	Susanville.
Sweetwater	Descanso.
Tamarack Canal	Imperial.
Temecula Creek	Temecula.
Tenaya Creek	Yosemite Valley.
Triumfo Creek	Calabasas.
Truckee	Mystic.
Truckee	Tahoe City.
Tule	Portersville.
Tuolumne	Lagrange.
Turlock Canal	Lagrange.
West Carson	Woodfords.
West Valley Creek	Likely.
West Walker	Coleville.
Willow Creek	Merrillville.
Willow Creek	Standish.
Wisteria Canal	Calexico.
Yosemite Creek	Yosemite Valley.
Yuba	Smartsville.
COLORADO.	
Animas	Durango.
Arkansas	Canyon City.
Arkansas	Pueblo.
Blue	Kremmling.
Canadian Creek	Cowdrey.
Cimarron	Cimarron.
Clear Creek	Forkscreek.
Conejos	Magote.
Eagle	Eagle.

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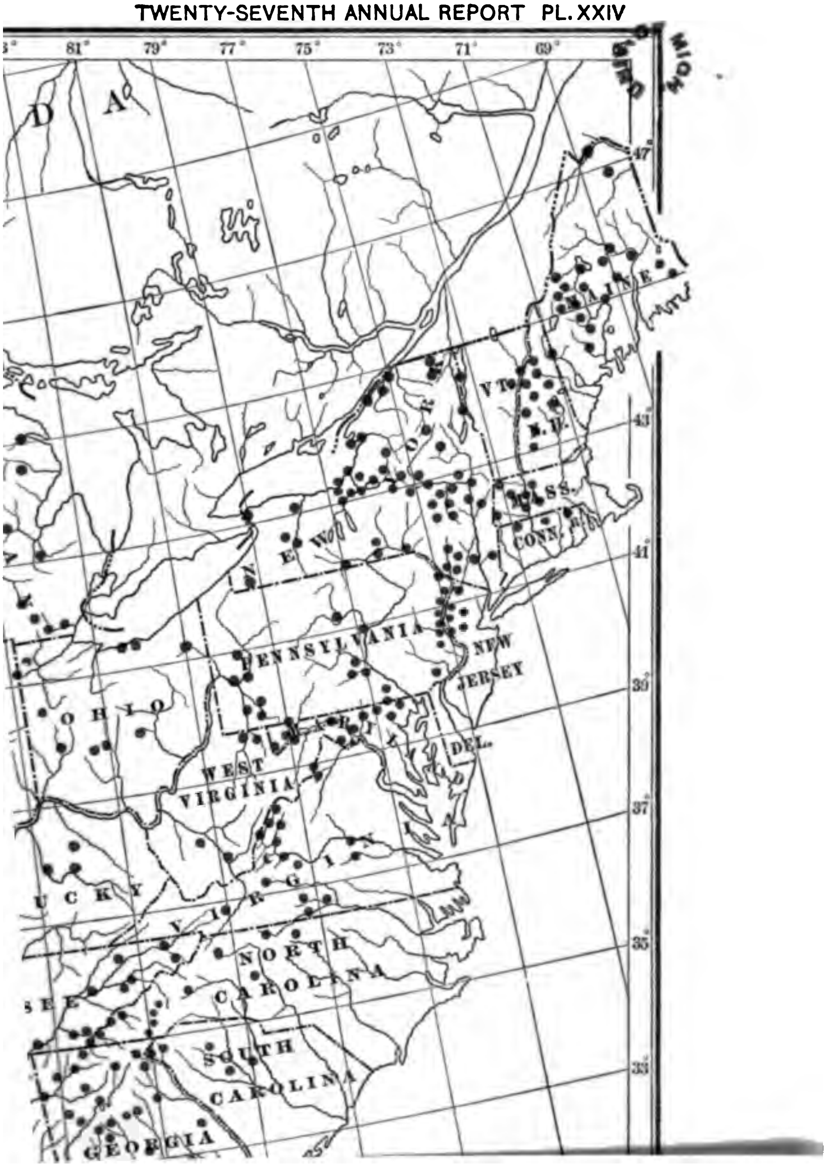

Gaging stations, by States, maintained during fiscal year 1905–6—Continued.

River.	Station.
COLORADO—continued.	
East	Almont.
Elk	Trull.
Elkhead Creek	Craig.
Fortification Creek	Craig.
Frazer	Granby (Coulter).
Grand	Glenwood Springs.
Grand	Hot Sulphur Springs.
Grand	Kremmling.
Grand	Palisades.
Grand (North Fork)	Grandlake.
Grand Lake (North Inlet)	Grandlake.
Grand Lake Outlet	Grandlake.
Grizzly Creek (Big)	Hebron.
Grizzly Creek (Little)	Hebron.
Gunnison	Cimarron.
Gunnison	Cory.
Gunnison	Portal of Tunnel.
Gunnison	Whitewater.
Gunnison (North Fork)	Hotchkiss.
La Plata	Hesperus.
Laramie	Glendevey.
Marvine Creek	Buford.
McIntyre	Gleneyre.
Michigan Creek	Cowdrey.
Michigan Creek	Walden.
Milk Creek	Axial.
Muddy	Kremmling.
North Platte	Cowdrey.
North Platte	Hebron.
North Platte (North Fork)	Higho.
Purgatory	Alfalfa (Barela).
Purgatory	Trinidad.
Rio Grande	Cenicero (Lobatos).
Rio Grande	Del Norte.
Roaring Fork	Glenwood Springs.
Roaring Fork	Hebron.
South Platte	Denver.
South Platte	Julesburg.
South Platte	Kersey.
South Platte	South Platte.
South Platte (South Fork)	South Platte.
Taylor	Almont (Summerville Park).
Troublesome	Troublesome.
Uncompahgre	Delta.
Uncompahgre	Colona (Eldredge Siding).
Uncompahgre	Montrose.
White	Meeker.
White	Rangely.
White (North Fork)	Buford.
White (South Fork)	Buford.
Williams	Hamilton.
Williams Fork	Hot Sulphur Springs.
Yampa	Craig.
Yampa	Maybell.
Yampa	Steamboat Springs.
CONNECTICUT.	
Housatonic	Gaylordsville.
Salmon	Leesville.
Shetucket	Willimantic.
GEORGIA.	
Alcovy	Stewart.
Apalachee	Buckhead.
Broad	Carlton.
Cannoochee	Groveland.
Cartecay	Cartecay.
Chattahoochee	Norcross.
Chattahoochee	Westpoint.
Coosa	Riverside.
Coosawattee	Carters.
Etowah	Canton.
Etowah	Rome.
Flint	Albany.
Flint	Montezuma.
Flint	Woodbury.
Ichawaynochaway Creek	Milford.
GEORGIA—continued.	
Kinchafoonee Creek	Leesburg.
Ocmulgee	Flovilla.
Ocmulgee	Jackson.
Ocmulgee	Macon.
Oconee	Dublin.
Oconee	Greensboro.
Oconee	Milledgeville.
Ohoopee	Reidsville.
Oostanaula	Resaca.
Savannah	Augusta.
Sweetwater Creek	Austell.
Soque	Demorest.
Tallulah	Tallulah Falls.
IDAHO.	
Bear	Dingle.
Bear	Preston (Battle Creek).
Bear Lake	Fishhaven.
Blackfoot	Presto.
Boise	Highland.
Cœur d'Alene Lake	Cœur d'Alene.
Fall	Fremont.
Lost (Big)	Chilly Station.
Lost (Big)	Mackay.
Payette	Jerusalem.
Snake	Minidoka.
Snake	Neeley.
Snake (North Fork)	Ora.
Snake (South Fork)	Lyon.
Succor Creek	Homedale.
Teton	St. Anthony
Wood (Big)	Shoshone.
ILLINOIS.	
Des Plaines	Channahon.
Fox	Sheridan.
Illinois	Peoria.
Kankakee	Momence.
Rock	Rockton.
Rock	Sterling.
Sangamon	Decatur.
INDIANA.	
Eel (Lower)	Cataract.
Kankakee	Davis.
St. Joseph	Fort Wayne.
St. Marys	Fort Wayne.
Tippecanoe	Delphi.
Wabash	Logansport.
Wabash	Terre Haute.
White (East Branch)	Shoals.
White (West Branch)	Indianapolis.
Yellow	Knox.
INDIAN TERRITORY.	
Canadian	Calvin.
Grand	Fort Gibson.
Verdigris	Catoosa.
IOWA.	
Cedar	Cedar Rapids.
Des Moines	Des Moines.
Des Moines	Fort Dodge.
Des Moines	Keosauqua.
Iowa	Iowa City.
Red Cedar	Janesville.
Wapsipinicon	Stone City.
KANSAS.	
Arkansas	Arkansas City.
Arkansas	Dodge City.
Arkansas	Hutchinson.
Arkansas	Syracuse.
Blue	Manhattan.
Cimarron	Arkalon.
Kaw (Kansas)	Lecompton.

Gaging stations, by States, maintained during fiscal year 1905–6—Continued.

River.	Station.
KANSAS—continued.	
Osage	Ottawa.
Republican	Junction.
Smoky Hill	Ellsworth.
Missouri	Kansas City.
KENTUCKY.	
Dicks	Danville.
Kentucky	Frankfort.
Salt (Rolling Fork)	Newhaven.
LOUISIANA.	
Bogue Chitto	Warnerton.
Sabine	Logansport.
MAINE.	
Androscoggin	Dixfield.
Aroostook	Fort Fairfield.
Carrabassett	North Anson.
Cold Steam	Enfield.
Dead	The Forks.
Fish	Wallagrass.
Kennebec	North Anson.
Kennebec	The Forks.
*Machias	Whitneyville.
Mattawamkeag	Mattawamkeag.
Messalonskee	Waterville.
Moose	Rockwood.
Penobscot	West Enfield.
Penobscot (East Branch)	Grindstone.
Phillips Lake	East Holden.
Piscataquis	Foxcroft.
Roach	Roach River.
St. Croix	Woodland (Baring).
St. John	Fort Kent.
Sandy	Madison.
MARYLAND.	
Antietam Creek	Sharpsburg.
Broad Ceek	Mill Green.
Deer Creek	Churchville.
Georges Creek	Westernport.
Gunpowder Falls (Little)	Belair.
Gunpowder Falls (Great)	Glencoe.
Monocacy	Frederick.
Patapsco	Woodstock.
Potomac	Point of Rocks.
Savage	Bloomington.
Wills Creek	Cumberland.
MASSACHUSETTS.	
Connecticut	Sunderland.
Deerfield	Deerfield.
Quabog	West Warren.
Swift	West Ware.
Ware	Gilbertville.
Ware	Ware.
Westfield	Russell.
Westfield (Little)	Blandford.
MICHIGAN.	
Au Sable	Bamfield.
Escanaba	Escanaba.
Grand	Grand Rapids.
Grand	North Lansing.
Huron	Dexter.
Huron	Flat Rock.
Huron	French Landing.
Huron	Geddes.
Kalamazoo	Allegan.
Manistee	Sherman.
Menominee	Iron Mountain.
Muskegon	Newaygo.
Reed Spring	Albion.
Rifle	Sterling.
MICHIGAN—continued.	
St. Joseph	Mendon.
St. Joseph	Buchanan.
Thunder Bay	Alpena.
Tittabawassee	Freeland.
MINNESOTA.	
Crow	Dayton.
Minnesota	Mankato.
Mississippi	Anoka.
Mississippi	Sauk Rapids.
Otter Tail	Fergus Falls.
Red Lake	Crookston.
Rum	Anoka.
MISSISSIPPI.	
Pearl	Jackson.
Tombigbee	Columbus.
Yazoo	Yazoo City.
MISSOURI.	
Courtois Creek	Scotia.
Gasconade	Arlington.
Meramec	Eureka.
Meramec	Meramec.
Meramec Spring	Meramec.
MONTANA.	
Agency Ditch	Harlem.
Beaver Creek	Ashfield.
Beaver Creek Overflow	Bowdoin.
Belt Creek	Belt.
Big Blackfoot	Bonner.
Bighorn	Fort Custer.
Bighorn (Little)	Crow Agency.
Bitterroot	Grantsdale.
Cherry Creek	Norris.
Clarke Fork	Fromberg.
Cook Canal	Chinook.
Cut Bank Creek	Cut Bank.
Deep Creek (Smith River)	Truly.
Fort Belknap Canal	Chinook.
Gallatin	Logan.
Gallatin (West)	Salesville.
Harlem Canal	Zurich.
Highwood Creek	Highwood.
Jefferson	Sappington.
Kennedy Creek	Babb.
Madison	Norris.
Marias	Shelby.
Matheson Canal	Chinook.
Milk	Havre.
Milk	Malta.
Milk (North Fork)	Chinook.
Milk (South Fork)	Browning.
Milk (West Fork)	Chinook.
Missoula	Missoula.
Missouri	Cascade.
Missouri	Greatfalls.
Missouri (Little)	Alzada.
Musselshell	Shawmut.
Paradise Valley Canal	Chinook.
Pryor Creek	Huntley.
Rock Creek	Hinsdale.
Rock Creek Canal	Hinsdale.
St. Mary	Dam Site.
St. Mary	International Line.
Sun	Sun River.
Sun (North Fork)	Augusta.
Sun (South Fork)	Augusta.
Swiftcurrent Creek	Babb (St. Marys).
Teton	Belleview.
Teton	Chouteau.
Willow Creek	Augusta.
Yellowstone	Billings.
Yellowstone	Glendive.
Yellowstone	Livingstone.

Gaging stations, by States, maintained during fiscal year 1905-6—Continued.

River.	Station.
NEBRASKA.	
Loup	Columbus.
Niobrara	Valentine.
North Platte	Bridgeport.
North Platte	Mitchell.
North Platte	North Platte.
Platte	Columbus.
Platte	Lexington.
Red Deer Lake	Woodlake.
Republican	Benkelman.
Republican	Bostwick.
Republican (South Fork)	Benkelman.
NEVADA.	
Carson	Empire.
East Carson	Gardnerville.
East Walker	Yerington.
Humboldt	Golconda.
Humboldt	Oreana.
Humboldt	Palisade.
Humboldt (North Fork)	Elburz.
Humboldt (South Fork)	Elko.
Lake Winnemucca Inlet	Wadsworth.
Muddy	Moapa.
Truckee	Vista.
Truckee	Wadsworth.
Walker	Wabuska.
NEW HAMPSHIRE.	
Ammonoosuc	Bretton Woods.
Androscoggin	Shelburne.
Connecticut	Orford.
Contoocook	West Hopkinton.
Israel, above South Branch.	Jefferson Highlands.
Israel, below South Branch.	Jefferson Highlands.
Little	Twin Mountain.
Merrimac	Franklin Junction.
Pemigewasset	Plymouth.
Saco	Center Conway.
Zealand	Twin Mountain.
NEW JERSEY.	
Delaware	Lambertville.
Musconetcong	Bloomsbury.
Passaic	Chatham.
Passaic	Millington.
Ramapo	Mahwah.
Raritan	Boundbrook.
Raritan	Finderne.
Raritan (North Branch)	Pluckemin.
Raritan (South Branch)	Rowland Mills (Stanton).
Wanaque	Wanaque.
NEW MEXICO.	
Animas	Farmington.
Gallinas	Las Vegas Hot Springs.
Gila	Cliff.
Hondo	Roswell.
Hondo	Reservoir Site, Roswell.
La Plata	Laplata.
Mora	Lacueva.
Mora Canal	Lacueva.
Pecos	Avalon.
Pecos	Carlsbad.
Pecos	Dayton.
Pecos	Fort Sumner.
Pecos	Lakewood.
Pecos	Roswell.
Pecos	Santa Rosa.
Penasco	Dayton.
Rio Grande	San Ildefonzo (Rio Grande).
Rio Grande	San Marcial.
NEW MEXICO—continued.	
San Francisco	Alma.
San Juan	Farmington.
Sapello	Los Alamos.
Ute Creek	Logan.
NEW YORK.	
Allegheny	Red House.
Black	Felts Mills.
Canada Creek (East)	Dolgeville.
Canada Creek (West)	Kast Bridge.
Canada Creek (West)	Trenton Falls.
Canada Creek (West)	Twin Rock Bridge.
Catskill Creek	South Cairo.
Chemung	Chemung.
Chenango	Binghamton.
Chittenango	Chittenango.
Delaware (East Branch)	Hancock.
Delaware (West Branch)	Hancock.
Esopus	Kingston.
Genesee	Mount Morris.
Genesee	Jones's Bridge, Mount Morris.
Genesee	Rochester.
Graefenberg Creek	New Hartford.
Honeoye Creek	East Rush.
Hoosic	Buskirk.
Hudson	Fort Edward.
Hudson	Mechanicsville.
Indian River	Indian Lake.
Johnson Brook	Utica.
Kinderhook Creek	Rossman.
Lake George Outlet	Ticonderoga.
Mohawk	Dunsbach Ferry.
Mohawk	Little Falls.
Moose	Moose River.
Oak Orchard Creek	Medina.
Oneida	Euclid.
Onondaga Lake Outlet	Long Branch.
Oriskany	Colemans, Oriskany.
Oriskany	State Dam, Oriskany.
Oswegatchie	Ogdensburg.
Oswego	Minetto (Battle Island).
Racquette	Massena Springs.
Richelieu	Fort Montgomery.
Rondout	Rosendale.
Salmon	Pulaski.
Saranac	Plattsburg.
Schoharie	Prattsville.
Schroon	Warrensburg.
Seneca	Baldwinsville.
Seneca Lake	Geneva.
Skaneateles Outlet	Willow Glen.
Susquehanna	Binghamton.
Wappinger Creek	Wappinger Falls.
NORTH CAROLINA.	
Catawba	Morgantown.
Dan	Madison.
Davidsons	Davidsons River.
French Broad	Asheville.
French Broad	Horseshoe.
Hiwassee	Murphy.
Mills (North Fork)	Pinkbed.
Mills (South Fork)	Sitton.
Nottely	Ranger.
Tennessee (Little)	Judson.
Tuskaseegee	Bryson City.
Valley	Tomotla.
Yadkin	Northwilkesboro.
Yadkin	Salisbury.
NORTH DAKOTA.	
Cannon Ball	Stevenson.
Des Lacs	Foxholm.
Heart	Richardton.
Knife	Broncho.

Gaging stations, by States, maintained during fiscal year 1905–6—Continued.

River.	Station.
NORTH DAKOTA—cont'd.	
Missouri	Bismarck.
Missouri	Nesson.
Missouri	Williston.
Missouri (Little)	Medora.
Mouse	Foxholm.
Mouse	Minot.
Muddy (Little)	Williston.
Pembina	Neche.
Red	Fargo.
Red	Grand Forks.
Sheyenne	Haggart.
OHIO.	
Black	Elyria.
Cuyahoga	Independence.
Great Miami	Dayton.
Licking	Pleasant Valley.
Mad	Springfield.
Mahoning	Youngstown.
Maumee	Sherwood.
Muskingum	Zanesville.
Olentangy	Columbus.
Scioto	Columbus.
Tiffin	Defiance.
OKLAHOMA.	
Arkansas (Salt Fork)	Alva.
Arkansas (Salt Fork)	Tonkawa.
Beaver	Beaver City.
Canadian (North Fork)	Woodward.
Canadian (North Fork)	El Reno.
Cimarron	Garrett.
Cimarron	Waynoka.
Elk Creek	Hobart.
Horse Creek	Mountain Park.
Otter Creek	Mountain Park.
Otter Creek (Dry Fork)	Mountain Park.
Red (Elm Fork)	Mangum.
Red (North Fork)	Granite.
Red (North Fork)	Headrick.
Red (Salt Fork)	Mangum.
Turkey Creek	Olustee.
Washita	Anadarko.
OREGON.	
Ana	Summerlake.
Bear Creek	Silverlake.
Bridge Creek	Silverlake.
Bully Creek	Vale.
Bully Creek	Warm Springs, near Vale.
Chewaucan	Paisley.
Clackamas	Barton.
Deschutes	Lava.
Deschutes	Bend.
Deschutes (East Fork)	Odell.
Deschutes (West Fork)	Lava.
Grande Ronde	Elgin.
Grande Ronde	Hilgard.
Hood	Winans City.
John Day	McDonald.
Klamath	Keno.
Klamath Lake	Pelican.
Link	Klamath Falls.
Lost	Merrill.
Luckiamute	Suver.
McKenzie	Hendricks Ferry.
Malheur Lake	The Narrows.
Malheur	Vale.
Malheur	Ontario.
Malheur	McLaughlins Bridge, Vale.
Malheur	22 miles above Vale.
Malheur (Middle Fork)	Riverside.
Miller Creek	Lorella.
Molalla	Dickey Prairie.
Owyhee	Owyhee.
OREGON—continued.	
Powder	Baker City.
Rock Creek	Arlington.
Rogue	Gold Ray.
Santiam	Jefferson.
Santiam (North Fork)	Mehama.
Santiam (South Fork)	Waterloo.
Siletz	Siletz.
Silver Creek	Riley.
Silver Creek	Silverlake.
Silver Lake	Silverlake.
Silvies	Burns.
Silvies	Silvies.
Summer Lake	Summerlake.
Sycan	Silverlake.
Tule Lake	Merrill.
Umatilla	Gibbon.
Umatilla	Umatilla.
Umatilla	Yoakum.
Umpqua (North Fork)	Oakcreek.
Umpqua (South Fork)	Brockway.
Walla Walla	Milton.
Walla Walla (South Fork).	Milton.
Wallowa Lake	Joseph.
Wallowa	Elgin.
Wallowa	Joseph.
Wallowa	Wallowa.
Willamette	Albany.
Willamette (Coast Fork)	Goshen.
Willamette (Middle Fork).	Jasper.
Willow Creek	Dell.
Willow Creek	Malheur.
Willow Creek	Arlington.
Yamhill (South Fork)	Sheridan.
PENNSYLVANIA.	
Allegheny	Kittanning.
Blacklick Creek	Blacklick.
Casselman	Confluence.
Juniata	Newport.
Kiskiminitas	Salina.
Laurel Hill Creek	Confluence.
Monongahela	Lock No. 4.
Susquehanna	Harrisburg.
Susquehanna	McCall Ferry.
Susquehanna	Danville.
Susquehanna (West Branch).	Williamsport.
Youghiogheny	Confluence.
SOUTH CAROLINA.	
Broad	Alston.
Savannah	Woodlawn.
Saluda	Waterloo.
Seneca	Clemson College.
Tugaloo	Madison.
Wateree	Camden.
SOUTH DAKOTA.	
Beaver Creek	Edgemont.
Belle Fourche	Bellefourche.
Box Elder Creek	Blackhawk.
Cheyenne	Edgemont.
Corbin and Morse Ditch	Rapid City.
Grand	Seim.
Hat Creek	Edgemont.
Missouri (Little)	Camp Crook.
Owl	Bixby.
Rapid Creek	Rapid.
Red Water	Bellefourche.
Redwater Canal	Minnesela.
Spearfish Creek	Spearfish.
Spring Creek	Rapid.
White	Interior.

Gaging stations, by States, maintained during fiscal year 1905-6—Continued.

River.	Station.
TENNESSEE.	
Duck	Columbia.
Hiwassee	Reliance.
Holston	Rogersville.
Holston (South Fork)	Bluff City.
Nolichucky	Greeneville.
Ocoee	McKays.
Pigeon	Newport.
Tennessee	Chattanooga.
Tennessee	Knoxville.
Tennessee (Little)	McGhee.
Watauga	Elizabethton.
TEXAS.	
Brazos	Richmond.
Brazos	Waco.
Colorado	Austin.
Colorado	Columbus.
Devils	Devilsriver.
Guadalupe	Cuero.
Guadalupe	Victoria.
Marguerretta Flume	Pecos.
Neches	Evadale.
Neches	Emporia.
Pecos	Moorhead.
Pecos	Pecos.
Red	Arthur City.
Rio Grande	Eagle Pass.
Rio Grande	El Paso.
Rio Grande	Langtry.
Rio Grande	Above Presidio.
Rio Grande	Below Presidio.
Rio Grande	Below mouth of Devils River.
Sabine	Longview.
Trinity	Dallas.
Trinity	Riverside.
UTAH.	
American Fork	American Fork.
Bear	Collinston.
Blacksmith Fork	Hyrum.
Blacksmith Fork Aqueduct	Hyrum.
Chalk Creek	Coalville.
Green	Greenriver.
Green	Jensen.
Green	Ouray.
Hobble Creek	Springville.
Indian Creek	Strawberry Valley.
Logan	Logan.
Lost Creek	Croydon.
Price	Helper.
Provo	Mouth of canyon, Provo.
Provo	Above Telluride Power Company's Flume, Provo.
San Pitch	Gunnison.
Sevier	Gunnison.
Sevier	Marysvale.
Spanish Fork	Lake Shore.
Spanish Fork	Spanish Fork.
Strawberry Creek	Strawberry Valley.
Weber	Devils Slide.
Weber	Oakley.
Weber	Plain City.
White	Dragon.
VERMONT.	
Otter Creek	Middlebury.
Winooski	Richmond.
VIRGINIA.	
Appomattox	Mattoax.
Banister	Houston.
Cooks Creek	Mount Crawford.
VIRGINIA—continued.	
Dan	South Boston.
Elk Run	Elkton.
Hawksbill Creek	Luray.
James	Buchanan.
James	Cartersville.
James	Holcomb Rock.
James (North Branch)	Glasgow.
Lewis Creek	Staunton.
New	Radford.
Passage Creek	Buckton.
Roanoke	Roanoke.
Roanoke	Randolph.
Shenandoah (North Branch).	Riverton.
Shenandoah (South Branch).	Front Royal.
South	Basic.
WASHINGTON.	
Asotin Creek	Shelman's ranch, Asotin.
Asotin Creek	Power House, Asotin.
Atanum Creek	North Yakima.
Cedar	Ravensdale.
Clealum	Roslyn.
Clealum Lake	Roslyn.
Chelan Lake	Chelan.
Chelan	Lake Chelan.
Columbia	Julia.
Columbia	Pasco.
Cow Creek	Keystone.
Grande Ronde	Zindel.
Hangman Creek	Tekoa.
Hangman Creek	Poole's ranch, Tekoa.
Hangman Creek (North Fork).	Tekoa.
Kachess	Easton.
Kachess Lake	Easton.
Keechelus Lake	Martin.
Methow	Pateros.
Naches	Nile.
Naches	North Yakima.
Naches	Below mouth of Tieton, near North Yakima.
Palouse	Elberton.
Palouse	Hooper.
Rock Creek	St. John.
Salmon Creek	Malott.
Skykomish (South Fork)	Index.
Snoqualmie	Snoqualmie Falls.
Spokane	Spokane.
Tieton	North Yakima.
Tieton	Dam site, North Yakima.
Wenache	Cashmere.
Yakima	Kiona.
Yakima	Martin (Lake Keechelus).
Yakima	Prosser.
Yakima	North Yakima (Selah Gap).
Yakima	Yakima (Union Gap).
WEST VIRGINIA.	
Cheat	Morgantown.
Greenbrier	Alderson.
Ohio	Wheeling.
Opequon	Martinsburg.
Potomac (North Branch)	Piedmont.
Potomac (South Branch)	Springfield.
Shenandoah	Millville.
WISCONSIN.	
Black	Neillsville.
Chippewa	Eau Claire.
Flambeau	Ladysmith.

Gaging stations, by States, maintained during fiscal year 1905–6—Continued.

River.	Station.	River.	Station.
WISCONSIN—continued.		WYOMING—continued.	
Oconto	Stiles.	Fall Creek	Fayette.
Peshtigo	Crivitz.	Green	Greenriver.
Wisconsin	Merrill.	Laramie	Jelm.
Wisconsin	Necedah.	Newfork	Cora.
Wisconsin	Rhinelander.	North Platte	Alcova.
Wolf	Northport.	North Platte	Guernsey.
Wolf	Shawano.	North Platte	Pathfinder.
		North Platte	Saratoga.
WYOMING.		Pine Creek	Pinedale.
		Piney Creek	Kearney.
Bighorn	Thermopolis.	Pole Creek	Fayette.
Boulder Creek	Boulder.	Shoshone	Cody.
Boulder Creek	Newfork.	Shoshone (South Fork)	Marquette.
Eastfork	Newfork.	Snake (South Fork)	Moran.

The total number of river stations maintained in the fiscal year 1902–3 was 519; in 1903–4, 639; in 1904–5, 754; in 1905–6, 817.

RIVER SURVEYS.

Surveys to determine the slopes of streams were made during the year on the following-named rivers: Penobscot, Moose, and Androscoggin, in Maine; Roanoke, in Virginia; Black, Flambeau, and Wisconsin, in Wisconsin.

SPECIAL INVESTIGATIONS.

Investigations were conducted which led to reports on the following special problems: The flow of water over standard and broad-crested weirs; the use of turbines as water meters; the flow of water under an ice cover; unusual and excessive floods of the year. Progress was made in the investigation of the effect of forestation upon run-off and of the movement and control of the débris of hydraulic mining in the basin of Sacramento River.

COOPERATION WITH STATES.

Cooperative arrangements for hydrographic work were made with eight States. The State Survey Commission of Maine allotted $3,500; the forestry commission of New Hampshire, $300; the State of Wisconsin, $1,250; the State of California, $10,000; the State of Oregon, $2,500; the State geologist of Maryland, a sum sufficient to pay all gage readers in that State; and the State engineers of Nebraska and Nevada, each a sum sufficient to pay for the services of a hydrographer who devoted his time to stream gaging.

PUBLICATIONS.

The following water-supply papers were issued:

124. Report of progress of stream measurements for the calendar year 1904, pt. 1, Atlantic coast of New England drainage.

125. Report of progress of stream measurements for the calendar year 1904, pt. 2, Hudson, Passaic, Raritan, and Delaware River drainages.

127. Report of progress of stream measurements for the calendar year 1904, pt. 4, Savannah, Ogeechee, and Altamaha rivers and eastern Gulf of Mexico drainages.

128. Report of progress of stream measurements for the calendar year 1904, pt. 5, eastern Mississippi River drainage.

129. Report of progress of stream measurements for the calendar year 1904, pt. 6, Great Lakes and St. Lawrence River drainages.

130. Report of progress of stream measurements for the calendar year 1904, pt. 7, Hudson Bay and Minnesota, Wapsipinicon, Iowa, Des Moines, and Missouri River drainages.

131. Report of progress of stream measurements for the calendar year 1904, pt. 8, Platte, Kansas, Meramec, Arkansas, and Red River drainages.

132. Report of progress of stream measurements for the calendar year 1904, pt. 9, western Gulf of Mexico and Rio Grande drainages.

133. Report of progress of stream measurements for the calendar year 1904, pt. 10, Colorado River and Great Basin drainages.

134. Report of progress of stream measurements for the calendar year 1904, pt. 11, the Great Basin and Pacific Ocean drainages in California.

135. Report of progress of stream measurements for the calendar year 1904, pt. 12, Columbia River and Puget Sound drainages.

147. Destructive floods in the United States in 1904.

150. Weir experiments, coefficients, and formulas.

156. Water powers of northern Wisconsin.

165. Report of progress of stream measurements for the calendar year 1905, pt. 1, Atlantic coast of New England drainage.

166. Report of progress of stream measurements for the calendar year 1905, pt. 2, Hudson, Passaic, Raritan, and Delaware River drainages.

167. Report of progress of stream measurements for the calendar year 1905, pt. 3, Susquehanna, Gunpowder, Patapsco, James, Roanoke, Cape Fear, and Yadkin River drainages.

168. Report of progress of stream measurements for the calendar year 1905, pt. 4, Santee, Savannah, Ogeechee, and Altamaha rivers and eastern Gulf of Mexico drainages.

169. Report of progress of stream measurements for the calendar year 1905, pt. 5, lower eastern Mississippi and Ohio River drainages.

171. Report of progress of stream measurements for the calendar year 1905, pt. 8, Hudson Bay and upper eastern and western Mississippi River drainages.

The following papers are in press:

162. Destructive floods in the United States in 1905.

170. Report of progress of stream measurements for the calendar year 1905, pt. 6, Great Lakes and St. Lawrence River drainages.

172. Report of progress of stream measurements for the calendar year 1905, pt. 8, Missouri River drainage.

173. Report of progress of stream measurements for the calendar year 1905, pt. 9, Meramec, Arkansas, Red, and lower western Mississippi River drainages.

174. Report of progress of stream measurements for the calendar year 1905, pt. 10, western Gulf of Mexico and Rio Grande drainages.

176. Report of progress of stream measurements for the calendar year 1905, pt. 12, Great Basin drainage.

178. Report of progress of stream measurements for the calendar year 1905, pt. 14, Columbia River and Puget Sound drainages.

180. Turbine water-wheel tests and power tables.

DIVISION OF HYDROLOGY.

The scope of the activities of this division remained unchanged during the fiscal year, its work including the investigation of the occurrence and development of underground waters. The two sections, the eastern and the western, had the same areas as in the previous year, the field of the first embracing the States east of Mississippi River and those bordering that river on the west, and that of the second including the so-called reclamation States and Territories and Texas.

COOPERATION WITH STATES.

There was less cooperative work with State organizations than in previous years, altho such work was conducted in a number of localities. In Connecticut the State survey aided in the investigation of underground waters by contributing information for a geologic map and otherwise assisting in the work. In Virginia the State survey cooperated in an investigation of the wells and springs, and a preliminary paper is expected to appear as a State report. In North Carolina both State and United States surveys worked on the underground waters under an arrangement whereby duplication of work is avoided. The Geological Survey of Georgia continued to act with this Survey in certain investigations, while a cooperative report was prepared with Alabama. Active field cooperation was continued in Iowa, the detailed investigation of the underground waters being nearly completed at the end of the year. Field cooperation in the study of the underground waters east of St. Louis was begun with the Illinois Geological Survey.

GENERAL INVESTIGATIONS.

The work of collecting well records and samples, the methods of which were described in detail in the report of the last fiscal year, was continued under the same plan. The work was extended during the year to nearly every State and Territory, especial attention being given to wild-cat wells and to wells in relatively little known fields. Borings for oil and gas as well as for water are included in the scope of this work. Nearly 2,000 records have been studied, and upward of 12,000 samples, including sets from about 900 wells and borings, have been examined, classified, labeled, and filed. The furnishing of expert advice to those applying for information concerning the occurrence of oil, gas, and artesian water, and for the interpretation of samples and records, was, as in the previous year, one of the most important parts of the work. The Survey was called upon by numerous State surveys, including Maryland, Alabama, Michigan, Kentucky, Iowa, Missouri, and Illinois, to supply records, and by the Geological Survey of Canada to furnish information as to the methods and appliances for collecting logs and samples.

Statistics of production and value of table and medicinal waters were collected for publication in the annual volume, Mineral Resources of the United States. A report on the occurrence, uses, and output of carbon dioxide was also compiled for publication.

The work on the general bibliography of underground-water papers appearing before 1905 was continued during the year, such time being devoted to it as could be spared from other work. It is hoped that it can be completed during the present fiscal year. In the meantime bibliographies of the current literature are being prepared, one covering all publications appearing in the United States in 1905 having already been submitted for publication.

The compilation of tables relating to the discharge of wells, composition of water, and numerous other problems encountered in underground-water investigation was completed, with the exception of certain discharge tables which are awaiting the results of experimental investigations on the relation of flow to height of jet now being conducted at the laboratories of Cornell University.

A general investigation of the methods of deep drilling in the various States in the East and in Texas, Oklahoma, and Kansas was made during the year, and the results were compiled for publication.

EASTERN SECTION.

WORK BY STATES.

Maine.—The collection of well, spring, and city water-supply statistics was completed and a detailed investigation of the geologic occurrence of water in granites, slates, limestones, and clays was begun.

New Hampshire.—The water supplies of the drift, including clays, river gravels, and drumlins, have been investigated in the southeastern portion of the State.

Massachusetts.—Studies of underground-water conditions in the Cape Cod region were conducted during the year. In the investigation of these certain problems of geologic correlation arose, which demanded the examination of areas outside the limits of the country. To supply this information, two members of the section visited Nova Scotia, Newfoundland, and Labrador, at private expense.

Connecticut.—Special attention was given to the occurrence of waters in the crystalline rocks of the State, with the object of obtaining accurate information on a number of points in regard to which there was general misapprehension on the part of the people. These included the prospects of obtaining water, the quantity and quality of the supply, the head in the wells, the most favorable locations for drilling, the depth to be drilled, etc.

New York.—Work on the mineral springs of the State, begun in 1903, was continued, a considerable amount of additional information was procured by correspondence, and much of the report was prepared.

Virginia.—The data collected in the previous fiscal year were compiled as a statistical report on wells and springs, to be published according to plans of cooperation by the State Geological Survey. A field investigation was also made of the underground waters of the Triassic rocks near Manassas.

North Carolina.—A party spent several months in the fall of 1905 in a study of the artesian waters in the Coastal Plain region about Wilmington and directed drilling operations in that region. A paleontologic study to determine the stratigraphy and structure of the water-bearing deposits was also taken up in June in connection with the work of the geologic branch, while another party investigated the waters of the Piedmont Plateau. Special investigations were also made of the ground-water conditions at Tarboro and Pinehurst.

South Carolina.—Portions of the Coastal Plain region in the northeastern part of the State were examined in connection with the studies of the underground waters of the Wilmington region of North Carolina.

Georgia.—The investigations in this State were limited to an examination of the mineral springs at Austell and of the large springs in Chickamauga Park and at Albany, to the study of blowing wells and springs, and to the investigation of the pollution of the water supply at Fort Oglethorpe in Chickamauga Park.

Florida.—A study of the practise and results of draining wet lands by wells and of the disposal of sewage thru borings was begun.

Alabama.—Field work was completed and a report prepared on the artesian waters of Alabama. This will be published as a State report.

Mississippi.—A report on the artesian waters of the State was completed and submitted for publication.

Tennessee and Kentucky.—A report on the underground waters of the Mississippi embayment area, or the territory lying west of Tennessee River, was finished and will be published as a water-supply paper.

Arkansas.—Field work on the underground waters in northeastern Arkansas was completed and the preparation of a report begun.

Missouri.—The examination of the underground waters was completed early in the fiscal year and a report prepared and submitted for publication.

Iowa.—Considerable work was done on the artesian waters and the waters of the drift during the year. It is expected that it will be possible to complete these studies in 1906.

Minnesota.—Progress was made on the report which is being prepared by a local geologist on the underground waters of the State.

Michigan.—Two reports on the water supplies of the southern peninsula, based on joint work by the glacial division of the geologic branch and the eastern section of hydrology, and a short report on the underground waters of the northern peninsula were prepared.

Illinois.—A detailed study of the ground waters of the district opposite St. Louis was begun, in cooperation with the State Geological Survey, which will contribute a large number of analyses.

PUBLICATIONS.

The following publications were issued:

Water-Supply Paper 145. Contributions to the hydrology of eastern United States.
Professional Paper 44. Underground-water resources of Long Island, New York.

The following papers are in the hands of the printer:

Water-supply papers:
155. Fluctuations of water level in wells.
159. Summary of the underground-water resources of Mississippi.
160. Underground water papers.
163. Bibliographic review and index of underground-water literature published in the United States in 1905.
164. Underground-water resources of Tennessee and Kentucky west of Tennessee River and of an adjacent area in Illinois.
182. Flowing wells and municipal water supplies in the southern portion of the Southern Peninsula of Michigan.
183. Flowing wells and municipal water supplies in the northern and central portions of the Southern Peninsula of Michigan.
Professional paper:
46. Geology and underground waters of northern Louisiana and southern Arkansas.

WESTERN SECTION.

WORK BY STATES AND TERRITORIES.

Arizona.—No new field work was done in this Territory, but progress was made in the preparation of two reports on investigations of previous seasons. One of these relates to the northwest corner of the Territory, and the other to the High Plateau region eastward.

California.—The work in the southwestern portion of this State was continued during a portion of the year, and a detailed investigation was begun of the underground-water conditions in the San Joaquin Valley. The report on the underground-water supplies in Owens Valley was completed and transmitted for publication.

Colorado.—No new field work was done in this State, but several reports presenting results of investigations made during previous seasons were prepared. The most extensive of these relates to the Arkansas Valley artesian area and is now in press (Professional Paper No. 52). It contains maps showing the geology, depths to Dakota sandstone, wells, flow area, intake zone, and other features, and cross sections illustrating the underground relations. In the Nepesta folio, recently published, there is a special sheet showing depths to water, area of flow, etc., in the region east of Pueblo.

The report on the artesian basin in the San Luis Valley is almost completed.

The report on the detailed investigation made of the underground waters and geologic structure of the Uncompahgre Valley is approaching completion. It will set forth the principal structural features and indicate all geologic conditions bearing on the underground-water problem.

Montana.—The geology of the Bighorn Mountains has been investigated and a report is now in press (Professional Paper No. 51). It has also been ascertained from the results of recent field work in the region north of the Black Hills that an artesian basin of great importance extends down the valley of Little Missouri River in the southeast corner of the State. The underground-water conditions in this area will be set forth in a report on the region north of the Black Hills, soon to be published.

Nebraska.—No new field work was done in this State, but reports on the artesian conditions in the northeastern and south-central portions of the State are being prepared and will soon be transmitted for publication.

New Mexico.—An extensive investigation has been made of the geologic structure in the south-central portion of the State, especially in the Rio Grande Valley and vicinity. Some of the results of this investigation have recently been prepared and transmitted for publication. A report on the Roswell artesian area is in press as Water-Supply Paper No. 158.

North Dakota.—Field work was continued in the Red River Valley artesian area and a portion of the country westward, especially with the view of preparing a general report on the underground waters of the State. The office work on the results has not yet been completed.

South Dakota.—The investigation of the underground-water conditions and geologic structure of the northern Black Hills region was continued and nearly completed. Progress was made in the preparation of the report on the results of this work, but additional data are required before it can be transmitted for publication. Work was also continued in the artesian area of the James River Valley, and the results of this investigation have been prepared for presentation in two folios, one comprising the Aberdeen, Northville, Redfield, and Lake Byron quadrangles, and the other the Elk Point quadrangle. These two folios contain a large amount of information regarding the underground-water conditions and are nearly ready for publication.

Texas.—During the last field season an investigation was made of the geology and underground-water conditions in the western half of the Panhandle. The El Paso folio has been completed and is ready for publication. It contains a detailed account of the underground-water conditions in a portion of the Rio Grande Valley.

Utah.—The field work in this State consisted of a detailed investigation of the underground-water conditions in the Sevier and San Pete valleys. A report of the results of this investigation is in preparation.

Wyoming.—Three parties continued field work in this State, partly to complete investigations begun in previous seasons and partly to begin investigations in areas which had not before been examined. The study of the structure of the uplifted beds along the flanks of the Bighorn Mountains was continued southward to the end of the range and then westward in the Bridger and Owl Creek mountains to the end of the latter. The results were incorporated in part in the report on the Bighorn Mountains (Professional Paper No. 51) and in part in a report on the Owl Creek Mountains and adjoining regions (published as S. Doc. No. 219, 59th Cong., 1st sess.), which contains a large amount of information relating to the portion of the Shoshone or Wind River Reservation, which is to be opened for settlement this summer.

The examination of the Bighorn basin was continued southward to include all of the area to the foot of the Owl Creek and Bridger ranges, and the results were incorporated in the report prepared last year, which has been transmitted for publication.

An investigation of the geologic structure and its bearing on the underground-water conditions in the Laramie basin was begun and nearly completed, and an examination was made of a portion of the foothills of the Laramie Range west of Cheyenne.

The results of the work of previous seasons in the Wyoming portion of the northern Black Hills were prepared for incorporation in the report on the northern Black Hills region.

PUBLICATIONS.

The following reports were issued:

Water-supply and irrigation papers:

123. Geology and underground-water conditions of the Jornada del Muerto, New Mexico.

136. Underground waters of Salt River Valley.

137. Development of underground waters in the eastern coastal plain region of southern California.

138. Development of underground waters in the central coastal plain region of southern California.

139. Development of underground waters in the western coastal plain region of southern California.

142. Hydrology of San Bernardino Valley, California.

148. Geology and water resources of Oklahoma.

149. Preliminary list of deep borings in the United States, second edition.

154. The geology and water resources of the eastern portion of the Panhandle of Texas.

157. Underground waters in the valleys of Utah Lake and Jordan River, Utah.

The following publications are in press:

Water-supply papers:
158. Geology and water resources of the Roswell artesian basin, New Mexico.
181. Geology and water resources of Owens Valley, California.
Professional papers:
51. Geology of Bighorn Mountains.
52. Geology and underground waters of the Arkansas Valley in eastern Colorado.
53. Geology and water resources of the Bighorn basin in Wyoming.

DIVISION OF HYDRO-ECONOMICS.

The investigations and reports of this division are confined to the quality of water and its suitability for domestic and industrial uses. The waters in by far the greater part of the country contain ingredients varying in amount, character, and degree of harmfulness. To secure the highest development of water resources it is necessary to determine these characteristics and to classify the waters according to their favorable or unfavorable effects upon different kinds of manufactured products and upon the health of the people.

WORK BY STATES.

Maine.—Analyses were made of daily samples of water from Androscoggin River for study of the effect of sulphite pulp wastes upon the water.

Massachusetts.—Investigations were made to determine the best methods of treatment of sulphite wood pulp wastes and strawboard wastes. The work was done in cooperation with the laboratory of sanitary research of the Massachusetts Institute of Technology.

New York.—The study of interstate pollution in the Hoosick drainage area was completed and investigation was made of the character of ground waters in the central part of the State.

Pennsylvania.—Unpolluted samples were collected in the eastern part of the State and examined for the purpose of constructing a normal chlorine map; in the Allegheny and Monongahela drainage areas a study was made of stream pollution and of the quality of water available for domestic and industrial purposes.

New Jersey and Delaware.—Unpolluted waters were collected and examined in order to obtain data for a normal chlorine map.

Maryland, Virginia, and West Virginia.—An investigation was made of the causes and effects of stream pollution in the Potomac River basin, and unpolluted waters were collected and sampled in order to determine the normal chlorine content.

Ohio.—Under cooperative agreement with the Ohio State board of health, investigations were carried on to ascertain the damage caused by various industrial wastes upon the water-supply resources of the State, and experiments were made to determine the best methods of purifying and recovering valuable ingredients in acid-iron wastes, dye wastes, and distillery slops. Investigations were made, also, of the efficiency of sewage-disposal plants and of the effects of the effluents upon streams and of the persistence of such ingredients in various rivers.

Kentucky.—Underground waters of the Blue Grass region were analyzed in order to determine their adaptability for household and industrial uses.

Illinois.—Preliminary investigations and negotiations were carried on preparatory to the execution of a cooperative agreement with the State water survey, the State board of health, the State Geological Survey, and the engineering experiment station of the University of Illinois.

Iowa.—An investigation was made of the character of ground waters from various water-bearing strata thruout the State for the purpose of determining the suitability of the waters for use in boilers and for manufacturing purposes. This work included a study of the methods of treatment necessary to make such water satisfactory for domestic and industrial purposes.

Minnesota.—Under a cooperative agreement with the State board of health, the field work for an investigation of the character of surface waters was completed and the report has been prepared in part.

Louisiana.—Analyses have been made of daily samples of water taken from Mississippi River above New Orleans for the purpose of determining the total amount of denudation in the Mississippi River system.

California.—Under a cooperative agreement with the State board of examiners and under an appropriation provided by the California general assembly, daily samples of water from the principal streams of the State were examined. The purpose of the work was to determine the amount and variability of the objectionable ingredients in the waters of the State, to ascertain the best methods of treatment, and to determine the seasons of the year during which the waters may best be impounded for domestic and manufacturing purposes.

PUBLICATIONS.

The following water-supply papers were issued:

144. The normal distribution of chlorine in the natural waters of New York and New England.

151. Field assay of water.

152. A review of the laws forbidding pollution of inland waters in the United States, second edition.

The following papers are in press:

161. Quality of water in the upper Ohio River basin and at Erie, Pa.

179. Prevention of stream pollution by distillery refuse.

PUBLICATION BRANCH.

EDITORIAL DIVISION.

SECTION OF TEXTS.

There were engaged in the work of the textual section of the editorial division about the same number of persons as last year—7 all of the time and 2 others much of the time—and the amount of work done was approximately the same, viz:

Manuscript pages edited, 35,131 (last year, 37,026), consisting of 1 Survey annual report, 1 Reclamation annual report, parts of 2 mineral resources annuals, 1 monograph, 8 professional papers, 24 bulletins, 30 water-supply papers, 15 geologic folios, and miscellaneous matter.

Proof read, final pages, 17,936 (last year, 18,382), consisting of 1 Survey annual report, 1 Reclamation annual report, parts of 2 mineral resources annuals, 13 professional papers, 18 bulletins, 41 water-supply papers, 13 geologic folios, and miscellaneous matter. These publications required the handling of 7,861 galley proofs and 32,256 page proofs (handled last year, 7,449 galley proofs and 33,415 page proofs).

Indexes prepared, 15,034 pages (last year, 15,530), for 1 Survey annual report, 2 Reclamation annual reports, 1 mineral resources annual, 12 professional papers, 16 bulletins, 37 water-supply papers, and miscellaneous matter.

In addition to performing the above-noted work on the regular series of publications, this section examined the copy and proofs of all account and record books and blanks, circulars, office cards, etc., and during the last five months of the fiscal year a considerable portion of the editor's time was given to the work of the assistant committee on editorial methods in the Departments.

SECTION OF GEOLOGIC MAPS.

At the beginning of the year work was in progress on 10 folios, all of which have since been published, and 12 others were on file. Four of these (Bald Mountain, Cloud Peak, Dayton, and Fort McKinney) have been combined into two double folios, and the Lancaster, Wis., has been combined with the Mineral Point folio. During the year 12 folios were transmitted to the section for publication, and 14 (Nos. 126 to 139, inclusive), as listed in the following table, were completed and issued:

Geologic folios issued during the fiscal year ending June 30, 1906.

No.	Name of folio.	State.	Mineral products occurring in area of folio.	Limiting meridians.	Limiting parallels.	Area.	Price.
						Sq. miles.	*Cents.*
126	**Bradshaw Mountains**	**Arizona**	Gold, silver, copper, iron, building stone, onyx marble.	112°-112° 30′	34°-34° 30′	986	25
127	Sundance	Wyoming, South Dakota.	Gold, tin, silver, lead, coal, gypsum, bentonite, underground water.	104°-104° 30′	44°-44° 30′	857	25
128	Aladdin	Wyoming, Montana, South Dakota.	Underground water, coal, gypsum, lime	104°-104° 30′	44° 30′-45°	849	25
129	Clifton	Arizona	Copper, iron, lead, gold, kaolin	109° 15′-109° 30′	33°-33° 15′	250	25
130	Rico	Colorado	Gold, silver, zinc, lead, building stone, lime	108°-108° 15′	37° 30′-37° 45′	236	25
131	Needle Mountains	do	Gold, silver	107° 30′-107° 45′	37° 30′-37° 45′	236	25
132	Muscogee	Indian Territory	Oil, coal	95°-95° 30′	35° 30′-36°	969	25
133	Ebensburg	Pennsylvania	Coal, clay, shale, building stone, underground water.	78° 30′-78° 45′	40° 15′-40° 30′	228	25
134	Beaver	do	Clay, coal, oil, gas, building stone	80° 15′-80° 30′	40° 30′-40° 45′	227	25
135	Nepesta	Colorado	Cement, iron, oil, gas, gravel	104°-104° 30′	38°-38° 30′	938	25
136	St. Marys	Maryland, Virginia	Clay, gravel, underground water	76°-76° 30′	38°-38° 30′	938	25
137	Dover	Delaware, Maryland, New Jersey.	Clay, marl, gravel, underground water	75° 30′-76°	39°-39° 30′	925	25
138	Redding	California	Gold, silver, copper, chromite, iron, lime, building stone.	122°-122° 30′	40° 30′-41°	906	25
139	Snoqualmie	Washington	Coal, iron, gold, silver	121°-121° 30′	47°-47° 30′	812	25

On June 30, 1906, 7 folios were in process of engraving and 11 were on file awaiting publication. The following tables give the names of these folios and the stage of progress each of those in process of engraving has attained:

Geologic folios in process of engraving, June 30, 1906.

Name.	Stage.
Amity, Pa	Engraving begun.
Bald Mountain-Dayton, Wyo	Maps being printed.
Cloud Peak-Fort McKinney, Wyo	Maps being printed.
Devils Tower, Wyo.-Mont	Engraving begun.
Lancaster-Mineral Point, Wis	Engraving begun.
Milwaukee Special, Wis	Engraving begun.
Nantahala, N. C.-Tenn	Color stones in preparation.

Geologic folios awaiting engraving, June 30, 1906.

Ann Arbor, Mich.
Elk Point, S. Dak.-Nebr.-Iowa.
El Paso, Tex.
Joplin District, Mo.-Kans.
Ouray, Colo.
Patuxent, Md.-D. C.
Penobscot Bay, Me.
Pisgah, N. C.-S. C.
Roan Mountain, N. C.-Tenn.
Rogersville, Pa.
Santa Cruz, Cal.

SECTION OF TOPOGRAPHIC MAPS.

On July 1, 1905, there were in the editor's files 85 atlas sheets and special maps, 21 of which had been edited and approved for engraving. Of the 64 remaining, 2, Massena, N. Y., and Johnstown, Pa., were afterwards withdrawn for additional field work, leaving 62. As a result of the field season of 1905, 97 new maps were received, 2 others, Catatonk, N. Y., and Farmington, Conn., were reduced from published atlas sheets, and Milwaukee Special, Wis., was made by combining parts of 4 contiguous atlas sheets. Of these 162 maps (62+97+3), 94 were edited and approved for engraving, leaving 68 now in hand. Eighty-three unpublished atlas sheets were in the custody of the editor on June 30, 1906, and had not yet been transmitted to the engravers. Fifteen of these were edited and approved.

The detailed proof reading of 109 atlas sheets, engraved and published during the year, was done in this section, as well as the proof reading of the corrections, more or less extensive, to 185 sheets. Sixteen of the latter were extensively corrected and published with new edition dates.

The number of unpublished topographic maps in hand at the close of the year was 115, which is 11 less than last year. Of these, 23 are products of the field season of 1904, but their engraving is well advanced, while 9 of the maps surveyed in 1905 have been published.

The editor of topographic maps is required to revise the geographic nomenclature on all of the maps which go as illustrations into the book publications of the Survey. During the year 243 of these map illustrations were examined.

The 18 mailing circulars, numbered 9–323, giving information concerning the topographic maps and folios published by the Survey, each illustrated by an index map, were all revised and reprinted during the year. Fourteen of them were revised and reissued twice each, and of the remaining 4, one edition of each was published. Besides these, index maps to illustrate 2 special circulars, showing results of "Cooperative topographic surveys," were prepared and proof read.

The Geographic Dictionary of Alaska, revised in this section and enlarged by more than 3,000 names and descriptions, is now in press as Bulletin No. 299.

DIVISION OF ENGRAVING AND PRINTING.

On July 1, 1905, there were reported on hand for engraving, manuscript atlas sheets and special maps to the number of 126. Two of these were afterwards withdrawn for additional field work, leaving 124. During the year, 97 new sheets were received from the topographic branch. Two were made by reduction and one by combination of published atlas sheets. This gives a total of 224 atlas sheets and special maps, grouped as follows:

Published during the year or in press at its close (double sheets counted as one)	109
In process of engraving at the close of the year	32
Not yet transmitted to the engravers	83

It appears, therefore, that at the close of the year there were in hand 115 unpublished atlas sheets and other maps, 11 less than last year, and that the engraving of 32 of these was in various stages of progress.

In addition to the engraving of new atlas sheets, corrections more or less extensive were made on the plates of 185 sheets. Editions of 298 sheets were printed and delivered during the year. Of these, 117 are new maps and 181 reissues, composed of 172 reprints and 9 maps bearing new edition dates.

During the year 14 geologic folios were published. In this number are 8 folios reported partly finished last year. The number now in hand partly completed is 10.

The need of photolithographic work has continually increased. In addition to that done in connection with the topographic branch, it is being extensively used for the work of the Reclamation Service. There is great need of more space in which to carry on this process and for the installment of additional apparatus.

The practise of making celluloid transfers, mentioned in the Twenty-fifth and Twenty-sixth annual reports, was continued this year, with uniformly satisfactory results.

The combined editions of the 14 geologic folios that were issued amounted to 60,227 copies, which required 2,611,400 printings. Of miscellaneous matter, such as map circulars, press bulletins, various blank forms, etc., there was necessarily a large amount printed, the number of copies being 652,926, which required 1,104,965 printings.

INSTRUMENT SHOP.

The work of the instrument shop consisted in overhauling and repairing surveying, drafting, and engraving instruments and in making copperplates and electrotypes. Upward of 1,200 repairs were made to instruments; 310 new copperplates and 23 electrotypes were finished.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

CORRESPONDENCE, RECORDS, APPOINTMENTS, SUPPLIES, AND SHIPMENTS.

Nearly every branch of the business mentioned under this head showed increase in volume.

Mails, files, and records.—There were received during the year 116,420 pieces of first-class mail. The recording and filing of the correspondence required the services thruout the year of two clerks.

Appointments, attendance, etc.—The number of changes of all kinds in the personnel was 1,160; during the preceding fiscal year, 1,114; increase, 46. Among the changes were 224 permanent appointments and 458 promotions.

There are now on the rolls of the Survey and Reclamation Service, of persons holding appointments from the Secretary of the Interior, 1,068 names, a net increase since June 30, 1905, of 76.

The attendance work has kept pace in volume with the development of the Bureau along other lines. Several changes were introduced during the year with a view to perfecting the system of recording absences and to obtaining from the several divisions of the Bureau more complete and reliable returns of attendance. The principal change was the adoption of a new form of record card, substantially the same card that had for some time been in use in most of the other bureaus of the Department.

Of applications for sick leave, there were 648, and of applications for leave without pay, 187, a total of 835, as compared with 800 handled during the previous year.

Property accountability.—The system of property accounting of the Geological Survey and the Reclamation Service underwent no radical change during the year, but an improvement tending to more accurate accounting was introduced.

On December 8, 1905, a committee was appointed, with the chief clerk as chairman, to pass upon the validity of affidavits pertaining to lost property in the field. This committee has placed before it the body of the affidavits only, the name of the affiant and location being omitted, in order that an impartial decision may be rendered. The findings of this committee are subject only to the review of the Director.

During the process of compiling property returns, 34,044 vouchers of disbursing agents were examined, together with the many accompanying subvouchers. An increase over last year of 11,947 vouchers is shown, and an increase in the volume of the work of 54 per cent.

The work connected with the preparation of abstracts of purchase, abstracts of property relieved of, and property returns of the Survey for the last fiscal year increased 6 per cent; for the Reclamation Service the increase was 41 per cent.

The amount of money derived from the sale at public auction of property examined by inspectors and found unserviceable was $4,667.58; during the preceding fiscal year $3,787.49 was received from the same source; increase, $880.09, or 23 per cent.

Preparation of vouchers.—There were 1,774 vouchers prepared for signature—no material increase over last year, a fact due to consolidation of all appropriations, with few exceptions, on one abstract of disbursements, which allows the describing of several appropriations on one voucher.

Purchase and distribution of supplies.—The work of this sort done during the year has been summarized as follows: Applications to Secretary of Interior for authority to purchase (involving an expenditure of $93,478.70), 284; requisitions drawn on Department for miscellaneous supplies, 495; requisitions filled from stock on hand, 662; orders drawn on dealers and others, 2,899; bills received and checked, 3,114.

Express, freight, and registered mail.—During the latter part of the year an improvement was made in the Survey bill of lading by reducing its size and attaching a coupon, to be detached by the consignee, advising the office of the shipment and the amount of the charges. It was also determined to extend the use of these bills of lading to express as well as freight shipments.

The amount of work performed is indicated by the following items: Freight and express, pieces shipped, 1,511; pieces received, 4,437; total, 5,948. Registered mail: Pieces forwarded, 9,305; pieces received, 2,358; total, 11,663. Accounts checked, 534.

The Reclamation freight and express accounts were formerly checked in this section but are now sent to the Reclamation Service direct.

Stationery.—In the stationery room the services of two men are required for the delivery of supplies thruout the office and for the wrapping and shipping of the same to the field parties. During the year 7,326 requisitions for blanks, blank books, and miscellaneous supplies were filled, and 948 requisitions were drawn on the Department, 564 being for printing and blank books and 384 for stationery supplies.

Miscellaneous.—Miscellaneous work consisted in securing customhouse entries, tracing shipments, issuing bills of lading, obtaining bids for supplies, making mimeograph copies of letters and circulars for the use of all branches of the Survey, etc.

SECTION OF DOCUMENTS.

There were delivered to this section during the year 145 new documents, 129 new maps, and 172 reprints of maps, a total of 446. They were: Twenty-sixth Annual Report; Monographs XXXII (atlas only), XLVII, XLVIII; Professional Papers Nos. 32, 34, 36, 38, 40–45, 47–49; Bulletins Nos. 150 (second edition), 176 (second edition), 208 (second edition), 243, 247, 251, 256, 257, 263, 265–274, 276, 278, 280, 281, 288; Water-Supply and Irrigation Papers Nos. 123–125, 127–154, 157, 165–169, 171; geologic folios Nos. 118, 121–135; Mineral Resources of the United States, 1904, and 42 separates therefrom; 4 separates from Mineral Resources of the United States, 1905; 3 miscellaneous publications; 301 topographic maps, the total combined editions of atlas sheets numbering 699,403; 6 photolithographic maps, the total editions numbering 4,642.

During the year 389,359 volumes, 65,975 folios, and 522,936 maps were sent out.

The total amount received and turned into the Treasury as a result of sales of publications was $17,634.89, an increase of $3,594.89, or more than 25 per cent, over the amount received during the preceding year. The use of Survey publications in schools and colleges seems to be increasing.

During the year 78,976 letters were received and answered (the preceding year 61,251), an increase of about 29 per cent.

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A summarized statement of disbursements follows. The chief disbursing clerk of the Survey acted also during the year as chief disbursing officer of the Reclamation Service.

Analysis of disbursements.

Geological Survey, 1906:		
Salaries of scientific assistants	$29,122.21	
Skilled laborers and temporary employees	19,997.84	
Salaries Office of Geological Survey	31,161.29	
Paleontology	9,575.42	
Chemical and physical researches	19,188.24	
Preparation of illustrations	16,773.19	
Books for the library	1,605.97	
Gaging streams	175,453.74	
Steel book stacks for library	5,683.35	
		$308,561.25
Geological Survey, 1905–6:		
Topographic surveys	337,568.48	
Geologic surveys	190,925.95	
Mineral resources of the United States	95,347.15	
Mineral resources of Alaska	78,943.25	
		702,784.83
Geological maps of the United States, 1906		98,272.55
Surveying forest reserves, 1905–6		128,196.75
Testing fuel		159,452.07
Testing structural materials		7,144.17
		1,404,411.62

FINANCIAL STATEMENT.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1906.

	Geological Survey, 1906.	Geological Survey, 1905–6.	Geological maps of the United States, 1906.	Surveying forest reserves, 1905–6.	Testing fuel.	Testing structural material.	Total.
Amount appropriated by act of March 3, 1905, and February 27, 1906	$339,920.00	$730,000.00	$100,000.00	$130,000.00			$1,299,920.00
Balance brought forward from previous report					$178,340.31	$7,221.07	185,561.38
Total	339,920.00	730,000.00	100,000.00	130,000.00	178,340.31	7,221.07	1,485,481.88
Amounts expended, classified as follows:							
Services	250,826.99	473,261.25	81,006.13	80,640.89	117,596.49	4,851.80	1,008,183.55
Traveling expenses	25,347.50	84,142.62	141.76	8,917.80	7,027.70	1,013.46	121,590.84
Field expenses, subsistence, and supplies	13,565.12	125,112.29		40,774.69	30,268.07	959.50	210,679.67
Instruments	4,599.45	4,845.18		871.50	2,062.27	13.50	12,391.90
Laboratory material	3,365.45	566.41			970.60	137.85	5,040.31
Photographic material	1,597.90	1,006.17			5.75		2,609.82
Books and maps	1,499.42	279.46			43.74		1,822.62
Stationery and drawing material	837.18	2,825.36		157.47	699.16	103.05	4,622.22
Illustrations for reports	287.25						287.25
Office supplies, repairs, and equipment	5,946.82	349.76		6.96	462.71	40.55	6,806.80
Correspondence	186.46	1,189.95	16.12	171.44	286.58	24.46	1,877.01
Material for engraving and printing maps			17,108.13				17,108.18
Railroad accounts settled by Treasury Department:							
Passenger	193.45	2,382.75		399.77			2,975.97
Freight	308.26	6,823.63	.41	1,256.23	27.00		8,415.53
Total expenditures	308,561.25	702,784.83	98,272.55	128,196.75	159,452.07	7,144.17	1,404,411.62
Balance unexpended July 1, 1906	31,358.75	27,215.17	1,727.45	1,803.25	18,888.24	76.90	81,069.76
Probable amount required to meet outstanding liabilities	31,358.75	27,215.17	1,727.45	1,808.25	18,888.24	76.90	81,069.76

LIBRARY.

Periodicals.—Approximately 300 periodical publications are regularly received. These are recorded on cards as received, and completed volumes, when bound, are entered in the accession book.

Books accessioned.—There were recorded in the accession book, in which is kept the complete and permanent record of books that are permanently added to the library, 2,666 books, making the total number of books entered 61,346.

Cataloguing.—The work of cataloguing the publications of the various State geological surveys has been continued. With the exception of those of New York, Pennsylvania, Kansas, California, and Washington, all these State publications have been catalogued and cards have been printed by the Library of Congress. The publications of the geological surveys of Sweden and Norway have also been catalogued. Some cataloguing has been done on the general geologic works, and the publications of this office have been catalogued as soon as received. All these manuscript cards are sent to the Library of Congress to be printed and distributed. A very large amount of duplication of cataloguing thruout the country is thus saved, the cards being sold at the cost of printing and of administration of the work. The sale of the Geological Survey cards is said to have greatly exceeded expectations. The total number of cards printed since this cooperative work was begun, on April 1, 1905, is 2,170.

Bibliographic work.—The annual bibliography and index of North American geology, paleontology, petrology, and mineralogy for 1904 was printed as Bulletin No. 271, and the regular edition as well as an extra edition of 500 copies is exhausted. The bibliography for 1905 is completed, and this material has been combined with the bibliographies for 1901, 1902, 1903, and 1904, the editions of which are exhausted, and the whole will be published as Bulletin No. 301.

Translations.—Letters in foreign languages received by the office, as well as a number of scientific articles, have been translated by members of the library force.

Purchase of books.—The appropriation of $2,000 for the purchase of material for the library has been fully expended. All purchases are made on the approval of the library committee except occasional material which is urgently needed.

Circular list of new publications.—During the year five lists have been published. An edition of 2,200 is being issued. These lists keep those most interested in the work of the office informed of what is being published and aid materially in thoroly and adequately distributing the publications.

Relations with other libraries.—The cooperative work, in cataloguing and printing cards, with the Library of Congress has been continued, and books are borrowed from and loaned to other Government libraries. Conferences have been had with other librarians as to methods to prevent duplication of work and unnecessary duplication of purchases of books. It is expected that definite plans will be adopted in the near future.

Foreign and domestic exchanges.—The greater part of the publications received in the library are obtained by exchange. All the book publications of this office are regularly sent to 400 foreign and 350 domestic exchanges. Four hundred and fifty sets of the map publications are also distributed. Considerable additions to the library are received from those to whom circular lists of new publications are sent and who select the particular publications desired. The lists, containing more than 3,000 addresses, are kept up to date in the library.

New steel book stacks and map cases.—Double-floor steel stacks, having a capacity of 20,000 books, and map cases to contain all the foreign and domestic reference maps have been installed and the books and maps are now in place. All the wooden stacks and map cases have been removed from the library. On account of the indemnity of $10 a day for nonperformance of contract there remained a balance of $1,018 of the appropriation unexpended. Contracts are now being made for additional pamphlet stacks and book and card stacks, which will require the expenditure of the greater part of this balance.

Committee work.—The librarian was appointed a member of one of the assistant committees to the committee on department methods—that on libraries—and spent considerable time on that work.

Field work.—From July 1 to October 10 the librarian was engaged in geologic field work in the West. During the winter months considerable time was given to the preparation of a report on the springs of New York State, which is now ready to be submitted for publication.

DIVISION OF ILLUSTRATIONS.

PHOTOGRAPHIC LABORATORY.

The increase in the output of the laboratory over last fiscal year is as follows: Glass negatives, 7½ per cent; lantern slides, 185 per cent; map prints, 4 per cent; mat prints, 2½ per cent.

Experiments have been started on collodion emulsion to replace and cheapen the wet-plate process at present used. The making of printing-out gelatine prints has been discontinued and developing paper substituted. By this means the uncertainty of sunlight is eliminated from the printing and prompt delivery insured.

A process has been introduced and improved for mounting prints dry by an electrically heated press, by which curling of the mount is entirely obviated. This process will be of great advantage in mounting the 6,000 prints which are to form the nucleus of the general geologic collection.

SECTION OF GRAPHIC ILLUSTRATIONS.

Illustrations to the number of 4,854, to accompany 74 publications, were prepared during the year, viz: Maps, 424; sections and diagrams, 941; paleontologic drawings, 2,740; photographs, 549; miscellaneous, 200.

At the close of the year the material to accompany 20 reports and papers was in hand, and a large number of the illustrations for these reports had been prepared.

Proofs to the number of 2,882 were received and examined critically, and the full printed editions of 176 plate inserts were examined at the Government Printing Office after delivery there by the contractors.

During the year 61 electrotypes were furnished to outside applicants.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

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APR 30 1908

TWENTY-EIGHTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1907

WASHINGTON
GOVERNMENT PRINTING OFFICE
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TWENTY-EIGHTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director*.

INTRODUCTION.

The plan of operations for the last fiscal year, including an itemized statement of the appropriations, amounting to $1,758,720, with the allotments thereof, was approved by the Secretary of the Interior on July 10, 1906. The work of the various branches and divisions conformed to this plan, and a detailed statement of their operations may be found on later pages.

On January 23 the former Director, Charles D. Walcott, was appointed to the position of Secretary of the Smithsonian Institution, and his resignation as Director was accepted by the President, becoming effective April 30, 1907. Mr. Walcott has been a member of the Survey since its organization, and the thirteen years of his service as the administrative head of the bureau cover the period of its greatest growth.

At the beginning of his directorship Mr. Walcott disclaimed any desire to make radical changes in either the policy or the administration of the Survey as developed under his predecessors, King and Powell, but in his first report, the Director's sixteenth, he mentioned certain readjustments which he deemed desirable in order that the Survey might better meet the economic and educational needs of the country. It is noteworthy that, almost without exception, these improvements have been accomplished, and even more fully than as then outlined. Among these changes may be mentioned: The raising of the standard of the topographic maps, with the representation thereon of land subdivision lines, and the extension of exact leveling and primary triangulation; the placing of the entire topographic and geologic force within the classified service; the obtaining of authority from Congress to issue separates of the annual report in pamphlet form, thus permitting advance publication of chapters of the Mineral Resources report, as well as of papers on economic geology; the enlargement of the work of the divisions of hydrography, mineral resources, and geology, in the last case providing for reconnaissance surveys of regions of economic importance.

Equally notable was the growth of the Survey under Mr. Walcott's administration, as shown by the increase in both the extent and the scope of its operations. The appropriations for the last fiscal year amounted to more than four times the total of those made thirteen years ago, and there was, of course, a corresponding increase in the amount of field and office work performed. The development of the relations between the Geological Survey and the public within the same period is measured by a more than fourfold increase in amount of official correspondence, nearly fourfold increase in number of printed pages in the various reports of the year, and a more than fivefold increase in copies of maps printed, while the total annual distribution of publications, books, and maps grew from less than 200,000 to nearly a million copies, the sales increasing from $2,100 to over $18,000. The extent to which the results of the work by this organization are now utilized by both the industrial world and the educational and scientific institutions furnishes the best index of the degree of success attained by Mr. Walcott and his colleagues.

ORGANIZATION.

The organization of the Survey was modified within the year by the creation of a technologic branch, by changes in the divisions constituting the topographic branch, and by the substitution of the name water-resources branch for hydrographic branch. As now organized the branches and divisions of the Geological Survey are as follows:

Branch.	Division.
Geologic	Geology and paleontology. Alaskan mineral resources. Mining and mineral resources. Chemical and physical research.
Topographic	Atlantic. Central. Rocky Mountain. Pacific.
Water resources	River-flow measurements. Ground-water investigations. Quality of water investigations. Débris investigations.
Technologic	Fuels. Structural materials.
Publication	Book editing and distribution. Map editing. Engraving and printing.
Administrative	Executive. Disbursements and accounts. Library.

The period of intimate connection between the Reclamation Service and the Geological Survey that had begun with the organization of this reclamation work as a separate division of the hydrographic branch of the Survey was terminated in March by acceptance of the resignation of Mr. Walcott as Director of the Reclamation Service. His successor, Frederick H. Newell, had been chief engineer of the Reclamation Service, and earlier chief hydrographer of the Survey, and he still retains connection with the Survey as a consulting engineer in the water-resources branch.

On April 4 the Secretary of the Interior changed the title of the administrative head of the geologic branch from geologist in charge of geology to chief geologist.

The reorganization of the topographic branch, on March 19, provided for five divisions in place of two, and on April 6 this plan was further modified by the consolidation of the northeastern and southeastern divisions into the Atlantic division. The four divisions thus formed correspond in name with the four geographic sections created in 1904 and later united into the two divisions. This reversion to the smaller administrative unit appears to be necessitated by the increase in the amount of work done in the topographic branch. The chiefs of these four divisions constitute a topographic committee, with the Director as chairman. Another important feature in the plan of reorganization was the formation of a section of inspection, three of the most experienced topographers being selected to serve as inspectors of topographic work.

The change from hydrographic to water resources in the name of that branch was made because the former did not correctly define the character of the work performed. The investigations are authorized by appropriations in successive sundry civil bills "for gaging the streams and determining the water supply of the United States and for the investigation of underground currents and artesian wells and the preparation of reports upon the best methods of utilizing the water resources."

On April 2 the Secretary of the Interior approved the Director's organization of the work progressing under the two appropriations for testing fuels and structural materials into the technologic branch, with two divisions corresponding to the two appropriations.

SPECIAL FEATURES OF THE WORK.

Cooperation of States.—Many of the States have continued the policy of cooperation with the National Survey, and the details of this cooperative work in geology, topography, and investigation of water resources are given on later pages of this report. On May 20–21 a conference was held between the representatives of 17 State survey organizations and the administrative heads of the various divisions of the Federal Survey. Current plans were discussed with a view to preventing possible duplication of work and to assure the fullest cooperation. This meeting was the outcome of an earlier conference of official geologists at New York in December, at which Director Walcott proposed the better coordination of the work of the State and Federal surveys.

General map of United States.—In recognition of the demand for general, as well as detailed, maps of the United States, plans have been perfected for the preparation of a map on a scale appropriate for a general map. The scale adopted by international agreement for a general map of the world is 1:1,000,000, or about 16 miles to the inch, and this appears well adapted to the present need. The proposed map will comprise 52 sheets, each one of which includes 4 degrees of latitude and 6 degrees of longitude. It will be employed primarily by the Survey as a base for a general geologic map of the United States, but the base will be designed with a view to all the manifold uses which Federal and State officials and the people have for a general map.

Surveys of coal lands.—Special investigations were conducted last year to determine the extent of the coal lands remaining in the possession of the Government and the quality and value of the coal deposits on these public lands. This work will be continued on a larger scale and under a more comprehensive plan. Special attention will be given to the classification and valuation of the coal lands and their prompt segregation from the noncoal lands. This work is to be provided for by a joint allotment from the appropriations for geologic and topographic surveys and that for testing coals belonging to the Government, and the General Land Office is also cooperating. The field operations were started before the close of the fiscal year.

Resignation of geologists.—The geologic branch of the Survey is experiencing embarrassment by its success as a training school for mining geologists. The increasing exodus of such geologists by reason of their employment by large mining companies at salaries much greater than those paid them by the Government seriously impairs the efficiency of the economic work of the Survey. During the last year the Survey has lost the services of seven geologists in this way.

Alaskan surveys.—The progress of areal surveys in Alaska is given in detail on later pages of this report, and it is pointed out that practically every mining camp has been visited and investigated. The importance of the rapid extension of such surveys can not be too strongly emphasized, for they furnish not only a guide to the prospector but are absolutely essential to all engineering enterprises. It is worthy of note that while nearly half a million dollars has been spent on Alaskan surveys and investigations, this is only about one-half of 1 per cent of the output of gold in the areas benefited by these surveys.

Tenth International Geological Congress.—The Geological Survey was represented at the Tenth International Geological Congress, held in Mexico in September, by a committee of delegates composed of Messrs. Emmons, Chamberlin, Hayes, Lindgren, Ransome, and Smith. Many courtesies were extended to the congress by the Government and the Geological Survey of Mexico, whereby its work was greatly facilitated. Conferences were held with the leading geologists of foreign countries relating to questions of correlation and other matters of general interest to geologists and geological surveys throughout the world. The most important result of the congress was to secure a larger degree of cooperation and coordination between this and other government surveys.

Water-resources work.—The ultimate purposes of the work relating to the water resources are Federal in character, the data so far collected being in the nature of a census of water-supply resources; and although there are various private uses to which they must necessarily have been put, the benefits to the Federal Government have been worth many times the amount invested in the work. For example, the United States is now expending more than $40,000,000 for the construction of irrigation works, the integrity of which rests upon the amount of water available for distribution from these systems. That it was possible for the United States to proceed to almost immediate construction of the reclamation projects is due to the fact that throughout the arid West the United States Geological Survey had for years previous collected records of stream flow, and a consultation of these records enabled the officers in charge of the reclamation work to determine at once which projects would and which would not be feasible. More recently, under an Executive order, a commission has been appointed, known as the Inland Waterways Commission, the purpose of which is to investigate and determine upon the broad policies to be followed by the Government with reference to the interstate rivers which make up the water highways under the control of the Federal Government. Almost immediately upon commencing its work this commission found it necessary to make use of the results of water-supply investigations that had previously been made by the Survey, and the work of the commission has been facilitated thereby.

Stream-flow measurements are needed in the South Atlantic States to secure a knowledge of the water resources, upon the utilization of which the industrial development must largely depend.

Reorganization of publication branch.—The reorganization of the publication branch, by placing under one head all work done in connection with the printing of reports, is expected to secure more effective administration with the same personnel. The importance of expediting the publication of the various reports issued by the Survey is realized, and plans are being perfected which it is hoped will remove some of the causes of delay. In this endeavor the Public Printer is extending hearty cooperation.

Changes in business methods.—Some changes in business methods have been made. These were necessitated both by the increase in the operations of the Bureau and by the demands made upon the Survey by the public. Such reforms have as their purpose expeditious action upon all financial transactions, with the least possible deviation from commercial practice; prompt and adequate action upon all correspondence with the public; and sufficient announcement of the Survey's current publications by means of press notices and official circulars.

WORK OF THE YEAR.

FIELD AND OFFICE WORK BY THE DIRECTOR.

During the months of August and September, 1906, the former Director studied in detail the Cambrian section of the Wasatch Mountains in northern Utah and southern Idaho and made large collections of fossils from various horizons in the section. After the 15th of October he proceeded to Nevada, California, Oregon, and North Dakota in connection with administrative matters relating to the work of the Reclamation Service.

During the spring and fall of 1906 and the winter of 1906–7 all his available time was given to the preparation of Monograph LI of the Survey and the writing out of field notes.

GEOLOGIC BRANCH.

ADMINISTRATION.

The geologic branch comprises four divisions, viz: (1) Geology and paleontology, (2) Alaskan mineral resources, (3) mining and mineral resources, and (4) chemical and physical researches. The chief of each division is responsible for the details of its administration, and the supervision of the chief geologist is required merely for the purpose of securing proper cooperation between the several divisions and coordination of the various lines of work. It has been found advantageous in many cases to employ the members of one division in the work of other divisions, and the form of organization permits ready transfer to meet most exigencies as they arise. This is especially desirable between the divisions of geology and mineral resources, and the geologists who have acquired special familiarity with certain classes of mineral deposits prepare the chapters on these deposits for the annual statistical volume on the mineral resources of the United States.

PUBLICATIONS.

The official publications of the geologic branch during the year included 14 geologic folios, 1 monograph, 6 professional papers, 26 bulletins, and the annual volume on mineral resources. Among the bulletins was the annual volume, " Contributions to Economic Geology," for 1906. Part I (Bulletin 315), containing 46 papers by 32 authors.

These publications embody the economic results and the principal contributions to science derived from the various investigations. In addition there were published, with the permission of the Director, in scientific journals and the transactions of scientific societies, a large number of papers based on work carried on by members of the geologic branch. It is the policy of the Survey to encourage such outside publication, which is ordinarily a restatement in more technical form of results and conclusions contained in reports already issued or in press. In some cases, also, original material obtained incidentally in connection with Survey work, but not appropriate for official reports, has been issued through unofficial publications. In no case has a member of the Survey received compensation for such material.

DIVISION OF GEOLOGY AND PALEONTOLOGY.

ORGANIZATION.

A few minor changes have been made in the organization of this division during the year. The most important, made toward the end of the year, were the increase in administrative responsibility placed upon the geologists in charge of the section of metalliferous deposits and the section of economic geology of fuels. This change was made primarily in the interest of more efficient administration and in recognition of conditions arising from the normal development of the organization, and also to relieve the geologist in charge of the division of some administrative details. It will probably be found desirable to further recognize this development in future by increasing the administrative responsibility of other section chiefs. Owing to changes in the personnel of the division, the positions of chief of the sections of petrology, economic geology of nonmetalliferous deposits, and glacial and physiographic geology became vacant within the year and have not yet been filled. The designation of the geologist in charge of the division was changed from geologist in charge of geology to chief geologist.

PERSONNEL.

The scientific force of the division at the beginning of the year consisted of 43 geologists, 3 paleontologists, 38 assistant geologists, and 5 geologic aids. Of these, 24 geologists and paleontologists, 21 assistant geologists, and 6 aids were occupied continuously throughout the year; the remainder, being on the per diem roll, gave only a portion of their time or none at all to Survey work. During the year resignations and appointments resulted in a net gain of 24 in the force. In addition to the above regular force, 32 field assistants were employed for a portion of the year.

CLASSIFICATION OF WORK.

The work of the division may be roughly grouped in the following six classes, the table also showing the percentage of the available funds devoted to each class of work:

Classification of geologic and paleontologic work.

	Per cent.
1. Areal and stratigraphic geology, with incidental study of economic mineral deposits	25
2. Economic geology, with incidental study of areal and stratigraphic problems	23
3. Investigation of geology of mineral deposits	16
4. Investigation of paleontologic and stratigraphic geology	17
5. Investigation of glacial and physiographic geology	8
6. Supervision and administration	11

ALLOTMENTS OF FUNDS.

The appropriations for geology and paleontology were allotted as follows:

Allotments for geologic work.

Work by States and Territories:	
Arizona (western), reconnaissance surveys	$2,388
Arkansas (northern), areal and economic surveys	587
Arkansas (northern), coal lands	1,900
California, hydraulic mining investigation	4,000
California, earthquake investigation	360
California, oil fields	2,487
Colorado, areal and economic surveys	9,006
Colorado, Georgetown mining district	292
Illinois, coal fields	1,618
Indian Territory. (*See* Utah.)	
Maine, peat and pegmatites	3,833
Massachusetts, areal and structural surveys	704
Missouri, St. Louis quadrangle, areal and economic survey	875
Missouri, lead and zinc deposits of the Wyandotte, Missouri-Oklahoma, quadrangle	3,350
Montana, mining geology of Philipsburg quadrangle	2,542
Montana, areal survey of Philipsburg quadrangle	4,180

Work by States and Territories—Continued.	
New Jersey, crystalline and metamorphic rocks	$1,325
New Jersey, mineralogy of the Franklin Furnace district	918
New York, Catatonk-Watkins Glen geologic folio	1,500
Oklahoma. (*See* Missouri.)	
Oregon, areal and economic survey of Riddles quadrangle	4,637
Pennsylvania (southeastern), iron-ore deposits	2,666
Pennsylvania (southeastern), areal and economic surveys in crystalline and metamorphic rocks	377
Texas, Van Horn quadrangle	150
Utah and Indian Territory, coal fields	3,982
Utah and Lake Superior, iron-ore deposits	5,000
Wyoming, iron-ore and limestone deposits	1,450
Wyoming, radioactivity of Yellowstone Park waters	500
General investigations:	
Adirondack stratigraphy	398
Appalachian (northern) coal fields	9,335
Appalachian (southern) coal fields	3,280
Appalachian (southern) iron ores	2,917
Appalachian (northern) oil fields and oil deposits in general	2,200
Atlantic Coastal Plain and Maryland	1,350
Cambrian stratigraphy and paleontology	3,918
Carboniferous stratigraphy	2,864
Carboniferous paleontology and stratigraphy of coal measures	3,335
Copper deposits in general	1,461
Cretaceous stratigraphy and supervision of paleontologic work	3,296
Devonian stratigraphy and paleontology	950
Editing geologic maps and areal and economic surveys in Pennsylvania, Maryland, and West Virginia	3,120
Geologic map of North America and of the United States	2,236
Glacial geology of Great Lakes region and New England	7,330
Glacial geology of the Sierra Nevada	2,850
Lead and zinc deposits in general and economic geology of the Park City, Utah, mining district	1,710
Magnesite deposits and steel-hardening metals	2,651
Supervision of areal geology and work in Massachusetts, North Carolina, and Georgia	4,580
Metalliferous ores in general and geology of the Leadville, Colo., district	5,690
New England granite deposits	2,531
Ordovician and Silurian stratigraphy and paleontology	3,824
Rocky Mountain coal fields	24,041
Supervision of geologic work in general	5,072
Triassic stratigraphy and paleontology of the Pacific coast	482
Administrative salaries	12,908
Clerical salaries	14,431
Petrographic laboratory	590
Repair of instruments	100
Skilled labor	6,307
Stationery	2,365
Technical salaries	4,800
Contingent	6,711
Total appropriation	213,700

Allotments for paleontologic work.

Coal-measure stratigraphy	$2,000
Fossil corals	2,400
Post-Paleozoic paleobotany and stratigraphy	2,500
Tertiary paleontology and stratigraphy	5,000
Triassic paleontology and stratigraphy	250
Vertebrate paleontology	337
Administrative salaries	83
Stationery	300
Contingent	1,130
Total appropriation	14,000

GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

New England.—A report on the granites of Maine, based on the previous season's field work, was completed early in the year by T. Nelson Dale. A thorough examination of the granite quarries and the granite industry in eastern Massachusetts and Rhode Island, similar to the examination of the Maine granites completed during the previous year, was made by Mr. Dale, and progress was made in the preparation of a report on the granite industry of southeastern New England.

Under the direction of George Otis Smith, Edson S. Bastin was engaged in field work and the preparation of reports on the peat and pegmatites of Maine. The Maine State Survey Commission cooperated in this geologic work by an allotment of $1,600. In June Mr. Bastin began the survey of the Eastport quadrangle for folio publication.

A survey of the area in Massachusetts covered by the Worcester, Marlboro, Webster, and Blackstone quadrangles was completed, and the Ware and Quinsigamond folios have been submitted by B. K. Emerson for publication. He has also carried forward work upon the compilation of the general geologic map of the States of Massachusetts and Rhode Island on a scale of 1 inch to 4 miles.

Before the publication of the Quinsigamond and Ware folios, Massachusetts, for which the geology of the crystalline rocks had been prepared by B. K. Emerson, it seemed desirable that the glacial deposits should be examined by a special expert. W. C. Alden, whose long training with Prof. T. C. Chamberlin eminently fitted him for this work, was therefore detailed to Massachusetts, and completed the study of the glacial deposits and the Pleistocene history of this region.

A survey of the glacial geology for the Housatonic and Taconic folios in Massachusetts and New York was continued from the previous season and completed by F. B. Taylor.

Atlantic Coastal Plain.—The study of the Atlantic Coastal Plain from New Jersey to South Carolina was continued under the supervision of William B. Clark.

In New Jersey some revision work was done on the Philadelphia and Trenton folios, chiefly for the purpose of correlating the Cretaceous and Tertiary formations with areas farther south. Professor Clark was assisted in this work by B. L. Miller and E. W. Berry.

In Delaware areal work was begun on the Wilmington quadrangle, and a reconnaissance of the several formations was made to procure data for the correlation of formations with those lying farther north and south. Most of the work in Delaware was done by B. L. Miller.

In Maryland the survey of the Tolchester quadrangle is nearly completed, and the Patuxent folio has already been submitted for publication.

A reconnaissance was made of portions of the Coastal Plain in Virginia, attention being given chiefly to Tertiary formations and to the determination of the divisions recognized in the Potomac section. This work was carried on by B. L. Miller, who devoted some time during the winter to the study of the fossils collected in earlier years as well as during the last field season.

In North Carolina field work was carried on in cooperation with the North Carolina Geological Survey by L. W. Stephenson, E. W. Berry, and B. L. Miller. Careful study was made of the Cretaceous formations of North Carolina and adjacent areas in South Carolina, and extensive collections of invertebrate and plant fossils were made.

Northern Appalachian region.—The report on the areal geology of the Watkins Glen and Catatonk quadrangles, New York, which was in its main features ready for publication at the close of last year, was referred back for critical study and elaboration by H. S. Williams. The whole area was restudied in greater detail, and the resulting correlations and classification are based upon exact paleontologic definitions of the various formations.

The relations of the Devonian and Carboniferous beds in New York and Pennsylvania were studied for six weeks by George H. Girty, and extensive collections of fossils were made from them.

The mapping of the gneisses and limestones of the Franklin Furnace special quadrangle was completed by A. C. Spencer, and the folio was prepared for publication.

The report on the investigation of the mineralogy of the Franklin Furnace district, New Jersey, was completed by Charles Palache, and a report is in preparation.

The mapping of the crystalline rocks of the Greenwood Lake quadrangle, in New Jersey and New York, was practically completed by W. S. Bayley, and some revision work was done on the crystalline rocks of the Raritan quadrangle, New Jersey.

Reports have been prepared on the pre-Cambrian rocks of the Passaic and Raritan quadrangles.

Geologic work in Pennsylvania was done in cooperation with the State, which had made an appropriation of $4,000 for this purpose. Detailed areal and economic surveys of the Johnstown, Clarion, and Sewickley quadrangles were nearly or quite completed. Additional work was done on the Punxsutawney, Curwensville, and Houtzdale quadrangles, Pennsylvania. The work in Pennsylvania was in charge of George H. Ashley, with whom were associated W. C. Phalen, Edwin F. Lines, M. J. Munn, F. B. Peck, and Lawrence Martin.

The surveys of the Nicholas quadrangle, in West Virginia, and the Kenova quadrangle, in Kentucky, Ohio, and West Virginia, were completed, and reports on these quadrangles were prepared for publication by Messrs. Ashley and Phalen.

A reconnaissance study was made of the Elkhorn coal field of Kentucky and of the Dickinson County coal field of Virginia by R. W. Stone, under the general supervision of Mr. Ashley.

A study of the geologic occurrence of the magnetite deposits of the Cornwall type in Berks and Lebanon counties, Pa., was made in October and November by A. C. Spencer. A preliminary account of this work was published in Bulletin No. 315, and the full report is in preparation.

Interesting deposits of white clay and of phosphate used in the production of phosphorus were examined in the vicinity of Mount Holly Springs, Pa., by G. W. Stose, and reports on these deposits were prepared for publication.

Construction of a combined paleobotanic and stratigraphic section of the Pennsylvanian series across the central Appalachian trough was continued by C. D. White. This section has now been carried from the western border of the coal field in Kentucky eastward a little beyond Pikeville, the paleobotanic work being extended to the new Elkhorn coal field.

The investigation of the stratigraphy and faunal relations of the Ordovician limestones in the Mercersburg and Chambersburg quadrangles, Pennsylvania, was carried on by G. W. Stose, in association with E. O. Ulrich, and the final maps and report on this region were prepared by Mr. Stose.

Additional work, found to be necessary for the adequate subdivision of Devonian formations in the Hancock, Pawpaw, Flintstone, and Frostburg quadrangles was carried on in cooperation with the Maryland Geological Survey by C. K. Swartz. This work was resumed in June, 1907.

The study of the stratigraphy and paleontology of the valley of Virginia was continued for a month in the latter part of the field season by R. S. Bassler, under the direction of E. O. Ulrich.

Southern Appalachian region.—The survey of the Birmingham district, Alabama, was continued from July to October by Charles Butts. Work on the Leeds and Bessemer 15-minute quadrangles, Alabama, was completed, and parts of the Birmingham and Coalville 15-minute quadrangles were resurveyed. This work consists of a detailed investigation of the stratigraphy and structure of the region, which have an intimate bearing on the economical development of the mineral resources. Special attention is given to the tracing out of formations with which the coal, iron, and flux materials are associated.

During the winter a report was prepared on the Cahaba coal field. Certain features of the geology of the region which required reexamination were reviewed by Mr. Butts in May and June, 1907.

Under instructions from the Secretary, Mr. Butts was detailed to the General Land Office for a few weeks for the examination and reclassification of the public lands of Alabama.

The detailed study of the Dahlonega district, Georgia, was completed by Arthur Keith.

Final details regarding the iron-ore deposits and the highly faulted Cambrian strata were secured by Mr. Keith for the Roan Mountain quadrangle, Tennessee, and the folio covering this quadrangle was prepared and submitted for publication.

GEOLOGIC WORK IN CENTRAL STATES EAST OF 97°.

A detailed survey was made of the Flushing quadrangle, Ohio, under the direction of W. T. Griswold, for the purpose of determining with more accuracy the structure of the oil sands and favorable localities for the extension of oil prospecting.

Collections of fossils from the basal Ordovician rocks in the Wells Creek basin in central Tennessee were made by R. S. Bassler, under the direction of E. O. Ulrich.

In cooperation with the Illinois Geological Survey, a paleobotanic reconnaissance of the Illinois coal field was made by C. D. White. This work was resumed in the spring of 1907.

The Eldorado and New Haven quadrangles, in southern Illinois, were surveyed by F. W. De Wolf, special attention being given to the economic geology.

A preliminary report was made by Mr. De Wolf on the Saline-Gallatin coal field of Illinois and published in "Contributions to Economic Geology, 1906." This work was done in cooperation with the State Survey.

An areal and economic survey was made of the east and west St. Louis quadrangles in cooperation with the State Survey of Illinois. About one-half of the area lies in Illinois, and the expenses of the work in this area were paid by the State. The work was in charge of N. M. Fenneman.

A few days were spent by E. M. Kindle in Illinois and Iowa studying the Devonian and Silurian stratigraphy and paleontology of those States.

The glacial and associated formations over a large tract bordering the north and west sides of the driftless area of the upper Mississippi Valley in Wisconsin, Minnesota, and Iowa were studied by Frank Leverett. This work was done under the immediate supervision of T. C. Chamberlin.

The active exploration of the iron-ore deposits in the Lake Superior region has developed many geologic facts. These were collected by C. K. Leith, and will be utilized in the final report on the geology of the Lake Superior district in a discussion of the origin of the iron ores.

An investigation was made during the year on the minerals associated with the copper deposits of the Keweenawan Peninsula, Michigan, and the report on the investigations is in preparation by Charles Palache.

The study of the stratigraphy and paleontology of the Ozark uplift was continued during July and August and part of September by E. O. Ulrich. The stratigraphic studies were extended around the southwestern and northwestern quarters of the Ozark area in Missouri, and a continuous section was made across the uplift.

Field work was carried on from October 1, 1906, to June 1, 1907, in the survey of the Wyandotte quadrangle in Kansas, Missouri, and Indian Territory by C. E. Siebenthal. Special attention was paid to the study of the lead and zinc deposits in that district, and reconnaissance examinations were made of the region intervening between the Wyandotte and the Independence (Kans.) quadrangles.

The survey of the Arkansas coal field was completed early in the year, and a full report on this field has been prepared by A. J. Collier.

A report on the faunas of the Guadalupian series, of the Manzano group, and of the Caney shale of Arkansas and Indian Territory was completed during the year by Mr. Girty and is ready for publication.

The northern half of the Eureka Springs (Ark.) quadrangle was reexamined in the early part of July by E. O. Ulrich and A. H. Purdue, to determine certain questions of geologic correlation.

The northern portion of the Harrison (Ark.) quadrangle was mapped in July and August by Mr. Purdue.

An examination of the phosphate deposits of northern Arkansas was made in August and September by Mr. Purdue, and a report on these deposits was prepared for the annual economic bulletin (No. 315).

The State of Arkansas has appropriated money for the cooperative investigation of the slate deposits of that State. This work has been placed in charge of A. H. Purdue, State geologist, and work was begun June 15.

GEOLOGIC WORK IN THE 16 WESTERN PUBLIC-LAND STATES AND TERRITORIES.

Rocky Mountain region.—In view of the urgent demand on the part of the public and of the Government for information regarding the western coal fields, special attention was paid to this subject. The work was placed under the immediate supervision of M. R. Campbell.

A survey was made of the western edge of the Durango-Gallup coal field, in Colorado and New Mexico, from Durango to the southern point of the field, near the Zuni Salt Lake. This party was in charge of M. K. Shaler.

The Book Cliffs coal field was examined from Grand River, Colorado, westward to Sunnyside, Utah. This work, by George B. Richardson, there connected with the work done the previous season by J. A. Taff.

The survey of the Yampa field, Colorado, begun in 1905, was continued southward to include the area of the Danforth Hills and Grand Hogback as far as Newcastle, on Grand River. This survey, as well as that of the Yampa field, was made by H. S. Gale.

In Wyoming the survey of the Uinta County coal field, made the previous year, was continued northward from Kemmerer to Snake River. This region, covered by A. R. Schultz, is exceptionally rough and mountainous, and the survey was carried on under serious disadvantages. The Carbon County coal field was surveyed by A. C. Veatch.

In Montana the Great Falls coal field, in Cascade County, was surveyed, by C. A. Fisher, from the Missouri River eastward to Stanford. In the eastern part of the State a rapid reconnaissance was made, by A. G. Leonard, of the coal field from Glendive to Miles City and thence northward to Hell Creek, on Missouri River.

At the request of the Department of Justice careful surveys were made of a part of the Book Cliffs coal field of Utah and of the Durango field of Colorado, in order to obtain data on which to base a classification of the lands. This was accomplished through the detail of J. A. Taff, a Survey geologist, to the Department of Justice. The specific information required by that Department was furnished and the geologic results were made available for publication in Survey reports.

Very little topographic work had been done in these fields, and it therefore was necessary for the geologists to prepare the topographic bases on which to present the geology. Special attention was paid to the determination of land lines on the ground wherever possible, and coal areas were segregated with reference to land corners. Plats showing classification of the land by legal subdivisions have been transmitted to the Land Office. Brief reports on these surveys have been prepared and transmitted for publication.

A special study of the stratigraphy and paleontology of the Dakota and associated formations in central Kansas and in Colorado along the foothills from the Cache la Poudre, near Fort Collins, to Canyon was made by T. W. Stanton.

The Cretaceous sections near Cerrillos and on Rio Puerco west of Albuquerque, N. Mex., were studied by Mr. Stanton, and collections were obtained from various horizons for purposes of correlation with adjacent areas on the west and north.

In October a brief study was made by Mr. Stanton of certain important locations in the Comanche series of Texas, on Devils River, near Del Rio, and on Bluff Creek, near Crawford.

In June, 1907, work was renewed in western Colorado by Mr. Stanton, who, with H. S. Gale, reviewed the sections studied by him during the previous field season between Newcastle, on Grand River, and Craig, on Yampa River.

The areal survey of the Engineer Mountain quadrangle, Colorado, was completed by Whitman Cross, and progress was made in the survey of the Lake City quadrangle, which was nearly completed. Surveys were also extended over a portion of the San Cristobal quadrangle, Colorado, chiefly by Albert Johannsen, under the direction of Mr. Cross. Reports on the results of the reconnaissance in western Colorado and eastern Utah in the season of 1905 were prepared by Mr. Cross, and also the Engineer Mountain folio. The results of studies of several years past in the San Juan Mountains have been correlated, and progress has been made in the preparation of reports.

A detailed areal survey was made of the Philipsburg (Mont.) quadrangle by F. C. Calkins. The quadrangle contains some important mineral deposits, which were studied in detail by a separate party, the work of Mr. Calkins forming the basis for such economic studies. Further work will be required for the completion of this quadrangle next year; it was begun by Mr. Calkins in June.

The detailed survey of the iron-ore deposits of the Iron Springs district, in southern Utah, was completed in the year by C. K. Leith and E. C. Harder. A month was devoted by Messrs. E. C. Harder and Freeman Ward to the study of the iron ores of Ashcroft and White Pine, and a short report on these deposits has been prepared.

A reconnaissance survey of the Uinta Range in Utah and a preliminary investigation of the recently discovered phosphate deposits in Idaho, Wyoming, and Utah was made by F. B. Weeks. A brief paper on this work was published in Bulletin No. 315.

The section of economic geology of metalliferous deposits remained in charge of S. F. Emmons until March 1, 1907, when Mr. Emmons, at his own request, was relieved of the duties, and Waldemar Lindgren was placed in charge of the section.

Progress has been made in the preparation and publication of reports on the Leadville district, Colorado, and sufficient work has been done in the field to bring the information up to date. A preliminary bulletin describing the Downtown district was prepared and is now published. (Bulletin No. 320.) A general map of the district, with detailed large-scale special maps, is in an advanced state of preparation.

An advance report on some of the new mining districts of Nevada was completed by F. L. Ransome early in July (1906) and has been published as Bulletin No. 303. This gives a preliminary account of Goldfield, Bullfrog, and other mining districts in southern Nevada, and is accompanied with notes on the Manhattan district by G. H. Garrey and W. H. Emmons.

Progress has been made on the final report on the geology and ore deposits of the Cœur d'Alene district, in Idaho, by F. L. Ransome and F. C. Calkins.

In October a preliminary examination of the Tombstone district, Wyoming, was made by Mr. Ransome.

The final report on the Park City mining district, Utah, was well advanced during the year by J. M. Boutwell, and a preliminary paper giving the results of greatest scientific and economic importance is now about ready for the printer.

A detailed investigation of the copper deposits of Shasta County, Cal., was made by L. C. Graton. A study of the areal geology of the Redding quadrangle had already been completed by J. S. Diller, and preliminary reports had been published on the mineral resources. The present work, however, is much more detailed than any previously undertaken in this region.

A general report on certain mining districts in northern New Mexico, examined by Mr. Graton in 1905, has been made ready for publication.

A detailed investigation was made of the mineral deposits of the Philipsburg quadrangle, Montana, by W. H. Emmons, who prepared a preliminary report on this district, which was published in the annual economic bulletin (No. 315).

The field study of the Bullfrog mining district, Nevada, was completed in January and February by W. H. Emmons, and the report on this district is approaching completion.

Numerous deposits of molybdenum and tungsten ores in Utah, California, and Arizona were visited by F. L. Hess, and a beginning was made in the field work necessary for the preparation of a report on the steel-hardening and other rare metals of the United States, which will be continued during the present year.

Under instructions from the Secretary, A. J. Collier was detailed to cooperate with officials of the General Land Office in the investigation of alleged mineral lands in the Colville Indian Reservation, Wash. This investigation extended from July to September.

In June, 1907, an examination was made by Mr. Collier of the recently discovered deposits of tin ore near Spokane, Wash. These deposits present points of special interest, and Mr. Collier was selected for their examination on account of the familiarity with tin deposits gained by him during his work in Alaska.

A thorough investigation of the thermal waters of the Yellowstone National Park was made by R. D. Moore and Herman Schlundt for determining its radioactive properties. Important and valuable results of both positive and negative character were obtained.

A reconnaissance examination was made of portions of the Burnet and Llano quadrangles, Texas, by F. L. Hess, chiefly for the purpose of determining the necessity for future detailed work in that region.

Pacific coast.—The report on the auriferous gravels of the Sierra Nevada, based upon field work accomplished in previous years, was completed by Waldemar Lindgren.

A detailed investigation was made of the magnesite deposits of California by F. L. Hess, and progress has been made in the preparation of a report.

A detailed areal and economic survey was made of the northern half of the Riddles quadrangle, Oregon, by J. S. Diller. The quadrangle contains important mineral deposits, and a paper on the nickel deposits of Nickel Mountain was prepared by G. F. Kay for the economic bulletin (No. 315). This work on the Riddles quadrangle was resumed in June and continued to the end of the fiscal year. September was spent by Mr. Diller in reviewing portions of the Roseburg quadrangle and completing a paper on the Mesozoic sediments of southwestern Oregon.

Several weeks were spent by Mr. Diller in northern California, completing field work for a paper on the geology of the Taylorsville region, which is now in course of publication as a Survey bulletin.

Detailed surveys were made of the Santa Maria and the Summerland oil districts, in Santa Barbara County, Cal., by Ralph Arnold. Special attention was given to the study of the stratigraphy and structure of these fields, with a view to furnishing information as to the extension of the productive area and for decreasing the cost of production by reducing the number of dry holes drilled. Reports on these districts were prepared. A preliminary one on the Santa Maria has been published (Bulletin No. 317) and the final (Bulletin No. 322) is in type. The report on the Summerland district is also in type. (Bulletin No. 321.)

Similar work was begun in June, 1907, on the Coalinga, McKittrick, Midway, and Sunset districts, which will be completed during the present fiscal year.

The investigation of glacial phenomena of the Sierra Nevada was continued by W. D. Johnson. Four months were spent in field studies, the inquiry being thereby extended from the basin of Walker River, in California and Nevada, into the contiguous basin of Lake Mono on the southeast. During the last half of the year the preparation of a report was continued by Mr. Johnson, with some field work, the office work being carried on in the vicinity of the field of study.

The investigation of the Triassic stratigraphy and paleontology of central Nevada was continued by J. P. Smith. Similar work was extended to southeastern Idaho, in Bear Lake and Bannock counties, where large collections of fossils were made and the stratigraphy was carefully worked out. A report was prepared on all material collected during the present and previous years and will soon be submitted for publication. This report will include an account of the entire marine Middle Triassic invertebrate fauna of America, with descriptions of several new genera, of some genera not heretofore described for America, and of a great number of new species.

Immediately after the occurrence of the San Francisco earthquake of April 18, 1906, the governor of California appointed a State earthquake investigation commission to make a study of its physical features. Two members of the Geological Survey, G. K. Gilbert and Harry Fielding Reid, were named as members of this commission. The Carnegie Institution of Washington and the Geological Survey have cooperated with the State in promoting the work of the commission, and the final report of the commission is to be issued by the Carnegie Institution.

Mr. Gilbert's chief contribution to the investigation was a report based on a field study of the part of Marin County about Bolinas and Tomales bays, a region which is traversed by the fault that caused the earthquake and which includes a belt of peculiar topography resulting from earlier dislocations of similar character. A general account of the earthquake ("The earthquake as a natural phenomenon") was also prepared by Mr. Gilbert, which served as an introduction to Bulletin No. 324, a composite publication consisting of reports of special investigations made soon after the earthquake and fire by several experts under the general direction of the Geological Survey's expert in charge of the investigation of structural materials.

GENERAL GEOLOGIC WORK.

An important investigation relating to that branch of river hydraulics which is concerned with the transportation of detritus by running water was continued in the laboratory at Berkeley, Cal., under the supervision of Mr. Gilbert. A great many experiments were made to determine the relation of detrital load to discharge of water, slope of stream bed, velocity, and other variables. This investigation promises results having an important bearing upon geologic theory. It is being carried on in cooperation with the water-resources branch and with the cooperation and assistance of the University of California, which furnishes space, power, and various important facilities.

The collection of all available data relative to earthquakes in the United States was continued throughout the year by Harry Fielding Reid. The information collected has made it possible to determine the focus and intensity of many light shocks. Arrangements have been made for the publication of these data in the Monthly Weather Review.

The permanent commission of the International Seismological Association held its first meeting in Rome last October. An appropriation was made, under the State Department, for participation on the part of the United States in this association, and Mr. Reid attended the meeting as a delegate from this country. The principal objects of the meeting were to formulate by-laws for the permanent commission, to discuss the budget, and to indicate the general policy of the association. A central bureau is to compile, study, and publish the records of all earthquakes, and the work of the association is to be confined to strictly seismologic matters. The delegates are to do all in their power to encourage seismologic studies and observations in their respective countries. Scientific questions were relegated to the general meeting of the association, which takes place next September at The Hague; and it was decided to offer a prize for the best form of seismograph presented at that meeting.

Progress was made in the preparation of a monograph on the flora of the Laramie and related formations by F. H. Knowlton. The technical descriptive portion of this work, which embraces about 450 species, was practically completed, and much of the geologic portion was prepared.

Progress was made in the preparation of a monograph on the Pottsville floras by C. D. White, but on account of precedence being given to the examination of collections submitted by various geologists this monograph has not yet been completed.

Work on fossil corals was continued throughout the year by T. Wayland Vaughan, and considerable progress was made in the preparation of a report on the Tertiary corals of southeastern United States and the West Indies. In connection with this work on fossil corals, collateral studies on recent faunas were made for the purpose of obtaining additional information on the classification of corals to be applied in the study of the fossils, and for the purpose of procuring data on the factors controlling the distribution of corals, to furnish the basis for the reconstruction of the physical conditions under which the fossil faunas lived. This work has been done in large part on material collected by the Fish Commission and material in the various museums throughout the country. A report on some Madreporaria corals from French Somaliland, East Africa, was published within the year in the Proceedings of the United States National Museum, and a report on a collection of similar corals in the Hawaiian Islands has now been published as a bulletin of the Museum.

The monograph on the Ceratopsia (Monograph XLIX), begun by the late O. C. Marsh and continued by the late J. B. Hatcher, was completed by R. S. Lull and submitted for publication within the year.

Some progress was made in the preparation of the Titanothere monograph by H. F. Osborn, with the assistance of W. K. Gregory. In the preparation of the section on the geologic succession of species it was found necessary to take up the entire question of the stratigraphy of the American Eocene of the Rocky Mountain basin region in which the Eocene Titanotheres occur, and also to do some field work in the Lower Oligocene formation of the Great Plains. Two field excursions during the summer of 1906 were made by Mr. Osborn with this object in view.

Work was also continued on the Sauropoda monograph by Mr. Osborn, with the assistance of Mr. Gregory. The special studies of the year were devoted to the structure of the skull and the brain, for which a large number of drawings were completed.

An exhibit to illustrate the recent progress in geologic science was prepared by J. S. Diller for the New York meeting of the American Association, and also an exhibit to illustrate the work of the Geological Survey for the Jamestown Exposition.

A subcommittee of the international committee on nomenclature spent some weeks in the field in the Adirondack region, and as a result of the field conference submitted a report recommending a uniform classification and nomenclature for Canadian and United States Survey reports.

In accordance with an agreement entered into with the geological surveys of Canada and Mexico, the United States Survey undertook the compilation of a geologic map of North America on a scale of 1:5,000,000. The work was placed in charge of Bailey Willis, by whom it was completed in August, 1906, and an edition of 1,500 copies was printed by order of the Mexican Government for the International Geological Congress at Mexico. This map forms the basis of a description of the geology of North America, which is being prepared by Mr. Willis for publication as a professional paper. The description and map are designed to constitute a report of progress in American geology and to be a material aid in teaching geology in schools and universities.

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under the appropriation of $80,000 for "continuation of the investigation of the mineral resources of Alaska." Under this authority the following classes of work were done: Reconnaissance and detailed geologic surveys, special investigations of mineral resources, reconnaissance and detailed topographic surveys, and investigation of water resources in reference to the supply of water available for placer mining.

PERSONNEL.

The personnel of the division included 1 geologist in charge and 9 other geologists on annual salaries. In addition to these, 4 geologists on per diem salaries were employed for a part of the time. Four topographers were continuously employed in the Alaskan work, and 2 engineers were detailed to the division, one for four months and the other for six months. Six temporary geologic assistants and 30 packers, cooks, etc., were employed in the field work for a period of from three to five months. The office force included 2 clerks on annual salaries and 1 clerk employed for six months.

FIELD OPERATIONS IN SEASON OF 1906.

In 1906 14 parties were engaged in field work during a period varying from two and a half to six months. Eight of these parties carried on geologic investigations, 2 made topographic surveys, 3 combined both classes of work, and 1 was employed in stream measurements and hydrographic reconnaissance. The aggregate of the areas covered by geologic reconnaissance surveys is 9,000 square miles; by detailed geologic surveys, 548 square miles. Topographic reconnaissance surveys were carried over an area of 10,768 square miles; detailed topographic surveys over an area of 40 square miles. Detailed hydrographic surveys were made of an area of 200 square miles, and reconnaissance surveys over an area of 1,000 square miles. In addition to this, of the 28 Alaskan mining districts in which work is going on 16, including all but one of the large producing districts, were visited by members of the staff.

The following table presents a summary of the progress of surveys since the organization of systematic work in 1898:

Progress of surveys in Alaska, in square miles.

Year.	Appropriation.	Geologic.		Topographic.		Hydrographic.	
		Reconnaissance.	Detailed.	Reconnaissance.	Detailed.	Reconnaissance.	Detailed.
1898	$46,189.60	9,500	....	14,912	....	....	....
1899	25,000.00	6,000	....	8,688	....	....	....
1900	25,000.00	10,000	....	11,152	....	....	....
1901	35,000.00	12,000	....	15,664	....	....	....
1902	60,000.00	17,000	....	20,304	336	....	....
1903	60,000.00	13,000	336	15,008	....	....	....
1904	60,000.00	6,000	....	6,480	480	....	....
1905	80,000.00	8,000	880	8,176	948	....	....
1906	80,000.00	9,000	548	10,768	40	1,000	200
Total	471,189.60	90,500	1,764	111,152	1,804	1,000	200

The actual areal surveys are tersely summarized in the above table, but many of the results can not be presented in this form. For example, practically every mining camp in Alaska has been investigated, and some in great detail, yet the areal results of surveys of this class are very meager. This will account for the fact that with increased appropriations there has not always been an increase in the areas surveyed. Moreover, in the last three years much of the funds has been spent in detailed surveys, which, roughly speaking, cost ten times as much as reconnaissance work.

The table shows that there remain nearly 500,000[a] square miles in Alaska which have not been covered even by reconnaissance geologic surveys. Until this work is much more nearly completed all generalizations on the distribution of the mineral wealth must remain largely hypothetical.

Preliminary topographic surveys, including about 50,000 square miles done by other Government bureaus, have been carried over less than a quarter of the entire area.

GEOGRAPHIC DISTRIBUTION OF INVESTIGATIONS.

General.—As in previous years, the general administrative duties were performed by Alfred H. Brooks, geologist in charge, who gave to them much of his time; but he also collected the statistics of the production of gold, silver, and copper. The general supervision of the topographic work was, as in previous years, intrusted to T. G. Gerdine.

In June the geologist in charge joined E. M. Kindle at Eagle, and together they made a careful study of the geology along the Yukon. The main purpose of the work was to procure data which would serve to elucidate the stratigraphic problems, but incidentally some facts were gathered bearing on the occurrence of placer gold and of coal. From Circle the geologist in charge went overland to Fairbanks, making an examination on the way of the Birch Creek placer district. A few days were then spent in the Fairbanks district, and at the invitation of Maj. W. P. Richardson, the geologist in charge joined the party of J. L. McPherson, engineer of the Alaska Road Commission, and carried geologic reconnaissance westward from Fairbanks to the Rapids on the Yukon, making also a brief visit to the Rampart district. The month of September was spent in Seward Peninsula with the parties working there and in making a study of the Kougarok placer district. A study of the stratigraphy of the Cretaceous and Tertiary coal-bearing rocks in the Territory was undertaken by W. W. Atwood for the purpose of establishing correlation and obtaining information on the relative commercial value of the different fields. The details of this investigation will be referred to later.

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[a] The area of Alaska is 586,400 square miles.

The preparation of the report on the mineral resources of the Prince William Sound region was continued by U. S. Grant.

Southeastern Alaska.—At the close of the last season the preliminary geologic mapping in southeastern Alaska was completed as far northwest as Lituya Bay. There still remains, however, the survey of the Chilkat basin, the inland parts of the larger islands, and the more inaccessible portions of the high ranges. The work of last year embraced an area of 3,000 to 4,000 square miles, extending northwestward from Lynn Canal to Lituya Bay and including a part of Chichagof Island, and was carried on by F. E. Wright and C. W. Wright, assisted by R. W. Pumpelly. Though it was principally geologic, some topographic reconnaissance surveys were made, and many data were collected on the retreat of the glaciers in the Glacier Bay region. At the close of the season C. W. Wright visited the Juneau and Ketchikan districts to collect data on the mining progress.

The urgent demand for detailed surveys of the more important mining districts in southeastern Alaska has been met, so far as the funds available would permit. In 1906 a survey was made, on a scale of a mile to the inch, of the more important parts of the Berners Bay district, embracing an area of about 40 square miles. This work was done by R. B. Oliver.

Yakutat-Alsek region.—Work in the Yakutat-Alsek Bay region was continued by R. S. Tarr and B. S. Butler. Mr. Tarr planned to cross the Malaspina Glacier to Yaktag, but the fissuring which had taken place in this ice field since his previous visit in 1905 made it impossible to carry out this plan. Mr. Tarr's observations in this region showed that an advance of some of the glaciers had taken place since 1905. This is of course exceptional for Alaskan glaciers; nevertheless, it may have an important bearing on the location of railway routes that traverse the fronts of ice sheets.

A geologic and topographic reconnaissance survey was carried from Yakutat Bay southward to Alsek River by Eliot Blackwelder and A. G. Maddren. It was also planned to ascend that stream to the international boundary, but a serious accident, which involved the loss of one of the boats and a large part of the provisions and equipment, prevented the accomplishment of this purpose.

Controller Bay region.—The mapping of the accessible coal and oil fields of this district, begun in 1905 by G. C. Martin, was completed.

Cook Inlet region.—The stratigraphy of the lignitic coal-bearing rocks on both the east and the west shore of Cook Inlet was started by W. W. Atwood, with an assistant. This was part of the general plan to study the coal-bearing rocks of Alaska, already referred to.

A party under the direction of T. G. Gerdine made a topographic and geologic reconnaissance survey of an area covering about 7,200 square miles lying northeast of and adjacent to Cook Inlet. Mr. Gerdine, accompanied by Adolph Knopf as geologist, mapped the valley of Knik River and portions of the lower Matanuska River and the area about its headwaters from Chickaloon Creek northward. R. H. Sargent, topographer, accompanied by Sidney Paige, geologist, mapped as far as practicable the area between Susitna and Matanuska rivers as far north as Chickaloon Creek and Talkeetna River, with an additional small area south of Knik River on the east side of Knik Arm.

At the end of the season Mr. Gerdine and Mr. Sargent completed a traverse of the shore line from Knik southward to the mouth of Kusilof River, while Mr. Paige and Mr. Knopf visited the Cook Inlet placer fields.

Seward Peninsula.—The areal mapping of the Nome and Grand Central quadrangles was completed by F. H. Moffit, assisted by P. S. Smith. This work is the first attempt to make an exhaustive study of the geology of any of the placer districts. It is hoped that as a result of such investigations general laws governing the occurrence and distribution of the placer gold of the peninsula may be formulated. Mr. Smith also made a reconnaissance of some of the other placer districts of the peninsula, both to gather data on the progress of mining and also to familiarize himself with some of the larger problems of the province.

The cheaper methods of placer mining are directly dependent on an abundant supply of water; therefore a knowledge of the water supply is of first importance to this industry. The accurate determination of the mean discharge of any given stream must be based on observations extending through a long period of years, to equalize the variations caused by abnormal seasons. Such an investigation was begun at Nome last season. The area investigated embraced a belt of country about 20 miles wide, stretching inland from Nome to the Kigluaik Mountains, a distance of about 40 miles, and was chosen both because of its commercial importance and because the detailed maps were available for calculating the areas of stream basins. It is hoped that funds may be available to continue this work and to extend it to other parts of Alaska.

These hydrographic surveys were made possible only through the cooperation of the water-resources branch, which detailed John C. Hoyt, engineer, to take charge. Mr. Hoyt spent about two months in the field, and the observations were continued by F. F. Henshaw.

Yukon district.—A geologic reconnaissance of an area of about 2,000 square miles, lying southwest of the lower Tanana, was made by L. M. Prindle, with one assistant. The Kantishna and part of the Bonnifield placer districts, as well as the Cantwell coal field, were embraced within the scope of the investigation. The stratigraphy of the Paleozoic rocks of the upper Yukon basin was studied by E. M. Kindle, with one assistant. In the course of this work Mr. Kindle ascended Porcupine River as far as the international boundary. This investigation has an important bearing on the correlation of the gold-bearing series of the Yukon-Tanana region.

Topographic reconnaissance surveys were carried westward from Fairbanks to the Yukon and southward to the Tanana by D. C. Witherspoon and R. B. Oliver. An area of 6,300 square miles was surveyed on a scale of 1:250,000. This completes the preliminary mapping of the Yukon-Tanana region west of the one hundred and forty-fourth meridian, except a narrow belt along the Tanana. It is expected that in another season the preliminary mapping of the area lying between Yukon and Tanana rivers and the one hundred and forty-second meridian will be completed.

FIELD OPERATIONS IN SEASON OF 1907.

Under a continuation of the same appropriation, 13 parties were dispatched to Alaska during the months of April, May, and June, while another will be sent early in July. The work of these parties includes a continuation of geologic and topographic surveys, and investigations of mineral resources in southeastern Alaska, in the Copper River region, in the Yukon basin, and in Seward Peninsula. The investigation of the water resources of the Nome region is also continued, and similar work is begun in the Fairbanks district.

DIVISION OF MINING AND MINERAL RESOURCES.

During the year the division was engaged in the preparation of reports on the mineral resources of the United States for 1905 and 1906. The report for 1905 was completed, published, and distributed, and the report for 1906 was prepared in part, manuscripts for many of the chapters being in hand and ready for publication as advance chapters of the volume. The figures so far in hand indicate that the year 1906 was by far the most prosperous ever known in the mining industry of the United States. The total value of all mineral products amounted last year to $1,900,000,000, a figure unprecedented in the history of the United States and an increase of more than 17 per cent over the value of the output in 1905.

The plan of utilizing the services of geologists in the permanent employ of the Geological Survey for the work of this division proved successful in the preparation of the report for 1905 and was continued last year. By means of this cooperation with the other divisions of the geologic branch advantage is taken of the existence in the Survey of a corps of trained men, who bring to the statistical work a keen appreciation of the geologic and economic importance of each mineral product based upon field observation. Especially successful has been the work on the subjects of gold and silver, copper, lead, zinc, and quicksilver by Waldemar Lindgren and other mining geologists. The report for 1906 will be prepared almost wholly by regular members of the Survey staff. Other divisions share the advantages of this cooperation, as the mining geologists derive from their statistical work an insight into the industrial and commercial conditions which so largely affect the demand for the different minerals.

The demand for information in regard to the black sands of the Pacific coast seemed to be sufficient to justify a continuation of that work for a short time in this fiscal year, and work was not closed there until the fall.

A considerable amount of the time of this division was consumed in answering technical inquiries and making visual examinations of several hundred mineral specimens which were submitted by the public for determination.

The chief of the division was occupied some time in organizing the mining exhibit at the Jamestown Tercentennial Exposition, in accordance with his designation for that purpose by the Secretary of the Interior, and as a member of the Government board representing the Interior Department at the exposition.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the chemical laboratory 195 quantitative analyses and 650 qualitative determinations were reported, covering the usual ground. Two of the rocks analyzed were unusual—a quartz-augite rock brought by W. T. Schaller from southern California and a pyrrhotite-bearing peridotite collected by E. S. Bastin in Maine.

In addition to the routine work of the division, scientific work was conducted as follows: A monograph on geochemistry, by F. W.

Clarke, was practically finished. In October, after a conference with Sir John Murray, Mr. Clarke obtained a composite sample of the oceanic "red clay," from 51 localities, which was analyzed in the Survey laboratory. Later another composite of 52 "terrigenous" clays was received, which was also analyzed. These analyses gave the average composition of two important sediments and revealed the presence in them of several elements which had not previously been detected in material of that kind. The greater part of the material came from the collections of the *Challenger* expedition.

A new edition of his bulletin on rock analysis (Bulletin 305) was prepared by W. F. Hillebrand, who also studied an important series of mercury minerals from Texas and a very remarkable vanadium ore from Peru. The latter may shed some light upon the origin of our Colorado-Utah ores. These investigations were extremely difficult and thorough. A bulletin (No. 312) describing his researches upon the chemistry of secondary enrichment was prepared by E. C. Sullivan, who is continuing his investigation. Routine analyses occupied most of the time of George Steiger, but he found time to study and develop certain analytical methods, which he has much improved. The numerous mineralogical determinations which are almost daily required were in charge of W. T. Schaller, who also made some investigations of noteworthy interest. The rare mineral powellite was identified from two new localities, under conditions which indicated its genesis. The mineral molybdite, or molybdic ocher, was found by Mr. Schaller to be not molybdic oxide, as hitherto assumed, but a hydrous ferric molybdate. Analyses of material from five localities gave concordant results. An interesting series of 12 minerals from the zinc mines of Franklin, N. J., were also analyzed by Messrs. Sullivan, Steiger, and Schaller. This material gave important information regarding several imperfectly known species.

In the physical laboratory the investigation of problems in geophysics was carried on by G. F. Becker, geologist in charge of the division, who also published a paper in the American Journal of Science on "Current Theories of Slaty Cleavage." The mathematical tables noted in the last report, of which C. E. Van Orstrand is a joint author, are ready for publication. The work on elasticity was continued under the immediate supervision of Mr. Van Orstrand. A well-equipped electric furnace, together with a measuring apparatus of high precision, has been constructed and is being used in an investigation of the elastic properties of metals, particularly steels, at high temperatures. A great number of observations have been made for the purpose of determining the variation of strain with stress as dependent upon time, and the variation of temperature and electric conductivity as dependent upon strain. Some time has been given also to a study of the transmission of vibrations in an elastic solid.

On January 1 A. L. Day and E. T. Allen left the Survey to enter the service of the Carnegie Institution. During the first half of the fiscal year, however, they continued their researches upon the synthesis of minerals. Mr. Allen, in particular, devoted most of his time to the study of diopside and tremolite.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch remained the same as it had been during the preceding year until March 19, 1907, up to which time H. M. Wilson, geographer, was in charge of the eastern division and E. M. Douglas, geographer, was in charge of the western division.

On March 19 five divisions were formed, the chiefs of which were to act as a topographic committee, with H. M. Wilson as chairman. These divisions, with their chiefs, were as follows:

1. Northeastern division, H. M. Wilson, geographer, in charge, with J. H. Jennings, topographer, as assistant.
2. Southeastern division, Frank Sutton, geographer, in charge.
3. Central division, W. H. Herron, geographer, in charge.
4. Rocky Mountain division, E. C. Barnard, geographer, in charge.
5. Pacific division, R. B. Marshall, geographer, in charge.

Geographer in charge of office, E. M. Douglas.

Geographer in charge of map editing, Henry Gannett.

Three inspectors of topography were appointed—John H. Renshawe, W. M. Beaman, and F. E. Matthes.

Because of the transfer of H. M. Wilson from the topographic branch to the technologic branch, which took effect April 6, the above organization was modified as follows:

The northeastern and southeastern divisions were consolidated into the Atlantic division, with Frank Sutton, geographer, in charge, and Van H. Manning and J. H. Jennings, topographers, as assistants.

George Otis Smith, then geologist, succeeded Mr. Wilson as chairman of the topographic committee.

PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment, under civil-service rules, of 10 topographic aids and the reinstatement of 1, and was reduced by deaths, transfers, and resignations amounting to 16. With these changes the technical force now includes 8 geographers, 37 topographers, 34 assistant topographers, and 10 topographic aids. Five employees of the technical corps are on leave without pay. In addition to the above regular force 209 field assistants were employed during the whole or part of the field season.

SUMMARY OF RESULTS.

The following summary includes all small-scale topographic surveys made by the topographic branch, including those in the national forests and by the division of Alaskan mineral resources.

Triangulation stations to the number of 281 were occupied or located and marked, and 3,156 miles of primary traverse were run. In the course of this work 40,000 square miles were covered by primary control.

The condition of topographic surveys to June 1, 1907, distinguished as to scale, etc., is shown on a general map of the United States (Pl. I).

As shown in the following tables giving the details of topographic mapping and spirit leveling for the fiscal year, the total of new surveys was 32,448 square miles. The total area surveyed in the United States to date is 1,025,065 square miles, or about 33 per cent.

In addition, 1,833 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 34,281 square miles.

In connection with these surveys there were run 5,797 linear miles of primary spirit levels and 1,595 miles of precise levels, making the total amount of primary and precise spirit leveling done since the authorization of this work by Congress, in 1896, 203,763 miles.

The total area covered by topographic surveys in Alaska during the fiscal year 1906–7, as reported in detail on pages 23–26, was about 10,808 square miles, 40 of which were on the scale of 1:62,500, and 10,768 on the scale of 1:250,000.

Present condition of topographic surveys of the United States, and new areas surveyed in 1906–7.

State or Territory.	New area surveyed in 1906–7.	Total area surveyed to June 1, 1907.	Percentage of total area of State surveyed to June 1, 1907.
	Sq. miles.	*Sq. miles.*	
Alabama	749	18,283	35
Arizona	337	62,712	55
Arkansas		20,469	38
California	4,405	79,381	50
Colorado	1,055	37,766	36
Connecticut		4,965	100
Delaware		1,008	43
District of Columbia		70	100
Florida		1,821	3
Georgia	26	16,855	28
Idaho		15,196	18
Illinois	1,055	7,400	13
Indian Territory	341	30,961	99
Indiana	16	2,458	7
Iowa	209	9,895	18
Kansas		64,159	78
Kentucky	724	14,515	36
Louisiana	225	7,923	17
Maine	290	6,805	20
Maryland		10,294	84
Massachusetts		8,266	100

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POGRAPHIC

Present condition of topographic surveys of the United States, and new areas surveyed in 1906–7—Continued.

State or Territory.	New area surveyed in 1906–7.	Total area surveyed to June 1, 1907.	Percentage of total area of State surveyed to June 1, 1907.
	Sq. miles.	*Sq. miles.*	
Michigan	440	3,753	6
Minnesota		2,876	3
Mississippi	253	906	2
Missouri	528	34,017	49
Montana	2,359	47,189	32
Nebraska		25,974	34
Nevada	4,297	40,482	36
New Hampshire	71	3,160	33
New Jersey	65	7,821	95
New Mexico	713	28,735	23
New York	633	38,209	80
North Carolina	429	17,074	33
North Dakota	62	8,775	12
Ohio	3,500	19,997	49
Oklahoma	1,024	5,534	14
Oregon	984	16,280	17
Pennsylvania	1,363	19,608	43
Rhode Island		1,248	100
South Carolina	168	5,496	17
South Dakota	142	17,956	23
Tennessee	242	20,103	48
Texas	1,306	65,845	25
Utah		63,820	75
Vermont	74	3,537	38
Virginia	366	29,829	70
Washington	1,257	18,228	26
West Virginia	1,544	24,120	99
Wisconsin	283	11,197	20
Wyoming	913	22,594	23
Total	32,448	1,025,065	

EASTERN DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic surveying was carried on in Alabama, Georgia, Illinois, Indiana, Indian Territory, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, West Virginia, and Wisconsin. The survey of 56 new quadrangles and of 1 special area was completed, also the resurvey or revision of 4 quadrangles. In addition, 14 new quadrangles were partly surveyed and 2 quadrangles and 1 special area were partly resurveyed. The total new area mapped was 13,594 square miles, of which 1,457 were for publication on the scale of 1:125,000, 12,137 were for publication on the scale of 1:62,500, and 74 were for publication on the scale of 1:24,000. The area resurveyed was 1,044 square miles, all for publication on the scale of 1:62,500. In connection with this work, 3,226 miles of primary levels and 1,266 miles of precise levels were run and 1,161 permanent bench marks were established.

Topographic surveys in eastern division from May 1, 1906, to June 1, 1907.

State.	Contour interval.	Scale of publication.			Total area surveyed.	Levels.	
		1:125,000.	1:62,500.			Distance run.	Bench marks.
		New.	New.	Resurvey.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Alabama	50	749	....	249	998	2	....
Georgia	20-50	6	20	213	239	76	29
Illinois	10-20	....	1,055	....	1,055	418	142
Indiana	20	....	16	....	16	51	37
Indian Territory	50	341	....	....	341	49	....
Iowa	20	....	209	....	209	71	....
Kansas	20	....	....	63	63	67	24
Kentucky	20	....	724	....	724	570	133
Louisiana	10	....	225	....	225	157	61
Maine	20	....	290	....	290	181	41
Maryland	20	....	....	357	357	182	46
Michigan	20	....	440	....	440	76	21
Minnesota	....	....	....	....	....	....	15
Mississippi	20	....	253	....	253	71	5
Missouri	20-50	299	229	42	570	170	29
New Hampshire	20	....	71	....	71	75	5
New Jersey	20	....	65	....	65	....	....
New York	20	....	633	....	633	132	28
North Carolina	10-20	....	429	....	429	281	69
North Dakota	50	62	....	....	62	102	27
Ohio	10-20	....	3,500	....	3,500	781	186
Pennsylvania	20	....	1,363	105	1,468	286	52
South Carolina	20	....	168	....	168	75	21
Tennessee	20-50	....	242	14	[a] 268	131	39
Vermont	20	....	74	....	74	42	11
Virginia	10-50	....	304	1	[a] 367	107	25
West Virginia	20-50	....	1,544	....	1,544	306	86
Wisconsin	10-20	....	283	....	283	110	80
Total	....	1,457	12,187	1,044	14,712	4,514	1,161

[a] 12 square miles in Tennessee and 62 square miles in Virginia for publication on the scale of 1 : 24,000.

DETAILS OF TOPOGRAPHIC FIELD WORK, BY STATES.

Alabama.—The resurvey of the Coalville quadrangle, consisting of 249 square miles in Shelby and Jefferson counties, was completed by W. M. Beaman, R. L. Harrison, and C. C. Gardner, for publication on the scale of 1: 62,500, with a contour interval of 50 feet, in connection with which 2 miles of supplementary primary levels were run.

Alabama-Georgia.—The survey of the Opelika quadrangle, for publication on the scale of 1: 125,000, with a contour interval of 50 feet, in Chambers and Lee counties, Ala., and Harris, Troup, and Muscogee counties, Ga., was nearly completed by J. H. Sinclair, R. W. Berry, and R. H. Reineck. The area surveyed was 755 square miles, 6 of which are in Georgia.

Georgia.—The resurvey of the Stilesboro quadrangle, in Polk, Barstow, and Paulding counties, was completed by Duncan Hannegan, who also commenced the mapping of the Columbus quadrangle, in Muscogee and Chattahoochee counties. The new area mapped was 20 square miles, the resurvey consisting of 213 square miles, all for publication on the scale of 1: 62,500, with contour intervals of 20 and 50 feet. In connection with this work 37 miles of primary levels were run and 5 permanent bench marks were established.

Illinois.—The governor of the State of Illinois allotted $10,000 for cooperative topographic surveys within the State, and the Director of the Federal Survey allotted a like sum for the same purpose. The mapping of the Breese, Galatia, and Wheaton quadrangles, in Blair, Clinton, Bond, Madison, Franklin, Hamilton, Saline, Williamson, Cook, and Dupage counties was completed, and the survey of the Tallula quadrangle, in Cass, Sangamon, Morgan, and Menard counties, was commenced. This work was done by W. J. Lloyd, C. L. Sadler, C. H. Hartmann, jr., and J. G. Staack. The total area surveyed was 906 square miles, for publication on the scale of 1 : 62,500, with contour intervals of 10 and 20 feet. For the control of these and other areas 163 miles of primary levels were run and 45 permanent bench marks were established.

Illinois-Wisconsin.—The survey of the Waukegan quadrangle was completed by Messrs. Lloyd and Staack, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. The area surveyed was 160 square miles, 149 square miles being in Lake County, Ill., and 11 square miles in Kenosha County, Wis. In connection with this work 37 miles of primary levels were run and 21 permanent bench marks were established, all being in Illinois.

Indiana.—The survey of the Saline City quadrangle, in Clay, Owen, Vigo, Sullivan, and Putnam counties, was commenced by W. H. Griffin, who completed 16 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

Indian Territory-Missouri.—The survey of the Wyandotte quadrangle, in District No. 1, Indian Territory, and Newton and McDonald counties, Mo., was commenced by C. G. Anderson and J. G. Staack. The area completed was 556 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet, 341 square miles being in Indian Territory and 215 in Missouri. In connection with this work 97 miles of levels were run and 4 permanent bench marks were established, 49 miles of level line being in Indian Territory.

Iowa.—The survey of the Waukee quadrangle, in Dallas, Madison, Polk, and Warren counties, was completed by Basil Duke, the area surveyed being 209 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of this area 71 miles of primary levels were run.

Kansas-Missouri.—The resurvey of the Leavenworth quadrangle, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet, was commenced by Glenn S. Smith, the area surveyed being 105 square miles, 42 square miles of which were in Platte County, Mo., and 63 square miles in Leavenworth and Atchison counties, Kans. For the control of this quadrangle 122 miles of primary levels were run and 34 permanent bench marks were established, 55 miles of level line and 10 bench marks being in Missouri.

Kentucky.—The director of the State Geological Survey of Kentucky allotted $10,000 for cooperative topographic surveys in the State, and the Director of the Federal Survey allotted a like sum for the same purpose. The survey of the Georgetown, Lockport, and Morganfield quadrangles, in Woodford, Fayette, Scott, Franklin, Jessamine, Owen, Henry, Shelby, Union, Webster, Crittenden, and Henderson counties, was completed by W. J. Lloyd, W. N. Morrill, A. O. Burkland, R. W. Berry, and L. Scott Smith, and work on the Providence and Monticello quadrangles, in Union, Webster, Crittenden, Hopkins, Caldwell, Russell, Wayne, Clinton, and Pulaski counties, was commenced. The total area surveyed was 724 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. For the control of these areas 383 miles of primary levels were run and 133 permanent bench marks were established.

Louisiana.—The mapping of the Baton Rouge quadrangle, in Baton Rouge, Iberville, and Ascension parishes, was completed by W. C. Hall and T. H. Moncure, who also commenced the survey of the Winnfield quadrangle, in Winn and Grant parishes. The total area surveyed was 225 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Winnfield quadrangle 24 miles of primary levels were run and 61 permanent bench marks were established.

Maine.—The State Survey Commission allotted $3,500 for cooperative topographic surveys in Maine, and the Director of the Federal Survey allotted a like sum for the same purpose. The survey of the Lewiston quadrangle, in Androscoggin, Kennebec, and Sagadahoc counties, was completed by Glenn S. Smith, Hersey Monroe, and C. H. Hartmann, who also commenced the survey of the Poland quadrangle, in Cumberland and Oxford counties. The total area surveyed was 290 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. For the control of these quadrangles 56 miles of primary levels were run and 41 permanent bench marks were established.

Maryland.—The State geologist of Maryland allotted $5,000 for cooperative topographic surveys in the State, and the Director of the Federal Survey allotted a like sum for the same purpose. The resurvey of the Laurel quadrangle was completed, and the resurvey of the old Frederick 30-minute quadrangle was commenced, the latter to comprise four 15-minute quadrangles, of which the Rockville was completed and the Mount Airy commenced. This work was done by Albert Pike, L. S. Leopold, W. O. Tufts, A. O. Burkland, and J. S. B. Daingerfield. The total area resurveyed was 357 square miles, in Anne Arundel, Howard, Montgomery, and Prince George counties, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and other areas 182 miles of primary levels were run and 46 permanent bench marks were established.

Michigan.—The State geologist of Michigan allotted $3,000 for cooperative topographic surveys in that State and the Director of the Federal Survey allotted a like sum for the same purpose. The survey of the Pontiac and Rochester quadrangles, in Oakland and Macomb counties, was completed by A. M. Walker, C. H. Birdseye, and H. L. McDonald. The total area surveyed was 440 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 76 miles of primary levels were run and 21 permanent bench marks were established.

Minnesota.—For the control of the Rockford quadrangle, in Hennepin and Wright counties, 15 permanent bench marks were established.

Mississippi.—The survey of the Florence quadrangle, in Copiah, Rankin, Simpson, and Hinds counties, was completed by J. W. Bagley and T. H. Moncure, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The area surveyed was 253 square miles, in connection with which 71 miles of primary levels were run and 5 permanent bench marks were established.

Missouri.—The survey of the Atlanta quadrangle, in Knox, Macon, and Shelby counties, was completed by T. Foster Slaughter, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The area surveyed was 229 square miles, in connection with which 18 miles of levels were run and 4 permanent bench marks were established. The survey of the Forsyth quadrangle, in Christian, Stone, and Taney counties, was completed by C. G. Anderson. The area surveyed was 84 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet, in connection with which 19 miles of primary levels were run and 4 permanent bench marks were established. For the control of the Macon quadrangle, in Macon, Monroe, Randolph, and Shelby counties, 30 miles of primary levels were run and 7 permanent bench marks were established.

New Hampshire-Vermont.—The survey of the Hanover quadrangle was completed by Charles Hartmann, jr., for publication on the scale of 1:62,500, with a contour interval of 20 feet. The area surveyed was 216 square miles, 71 of which were in Grafton and Sullivan counties, N. H., and 145 in Windsor County, Vt. For the control of this work 19 miles of primary levels were run and 5 permanent bench marks were established, all being in Vermont.

New York.—The State engineer and surveyor allotted $9,500 for the continuation of cooperative topographic surveys in the State and the Director of the Federal Survey allotted a like sum for the same purpose. The survey of the Loon Lake, Potsdam, and Goshen quadrangles, in Franklin, St. Lawrence, and Orange counties, was completed by J. H. Jennings, C. E. Cooke, Gilbert Young, W. O. Tufts, and Fred Graff, jr.; also the Port Jervis quadrangle, in Orange and Sullivan counties, N. Y., and Sussex County, N. J. All this work was done for publication on the scale of 1:62,500, with a contour interval of 20 feet. The total new area surveyed was 633 square miles in New York and 65 square miles in New Jersey. For the control of this work 132 miles of levels were run and 28 permanent bench marks were established.

North Carolina.—The commissioner of agriculture of North Carolina allotted $4,000 for the continuation of cooperative topographic surveys in the State, and the Director of the Federal Survey allotted a like amount for the same purpose. The survey of the Beckford, Four Oaks, and Winton quadrangles, in Chowan, Gates, Hertford, Perquimans, Johnston, Wayne, Sampson, Hartnett, and Bertie counties, was completed by W. C. Hall, C. D. S. Clarkson, W. O. Tufts, and F. Graff, jr. The area surveyed was 353 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of this work and that in the Salemberg quadrangle, 224 miles of primary levels were run and 51 permanent bench marks were established.

North Carolina–South Carolina.—The survey of the Kings Mountain quadrangle was completed by W. L. Miller and T. H. Moncure, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The area surveyed was 244 square miles, 76 square miles of which were in Cleveland and Gaston counties, N. C., and 168 square miles in York and Cherokee counties, S. C. For the control of this and the Gaffney quadrangle, in Cleveland and Rutherford counties, N. C., and Cherokee County, S. C., 132 miles of primary levels were run and 39 permanent bench marks were established, 75 miles of levels and 21 bench marks being in South Carolina.

North Dakota.—The survey of the Ray quadrangle, in Wallace and Williams counties, was commenced by Basil Duke, who completed 62 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet, in connection with which 102 miles of primary levels were run and 27 permanent bench marks were established.

Ohio.—The governor of the State of Ohio allotted $23,800 for the continuation of cooperative topographic surveys, and the Director of the Federal Survey allotted a like sum for the same purpose. The following quadrangles were completed: Ashland, in Ashland, Richland, and Huron counties; Bidwell, in Gallia, Jackson, and Lawrence counties; Chillicothe, in Ross, Vinton, and Pickaway counties; Chagrin Falls, in Cuyahoga, Geauga, Summit, and Portage counties; Columbus Grove, in Putnam and Allen counties; Deshler, in Henry, Wood, Hancock, and Putnam counties; Middletown, in Butler, Preble, Montgomery, and Warren counties; New London, in Ashland, Huron, and Lorain counties; Ravenna, in Mahoning, Portage, and Trumbull counties; St. Henry, in Mercer and Darke counties; Warren, in Mahoning and Trumbull counties; Waverly, in Ross, Pike, Jackson, and Vinton counties; West Salem, in Ashland, Medina, and Wayne counties; Youngstown, in Mahoning and Trumbull counties; and, in addition, the Ohio portion of the Athalia, Point Pleasant, Ravenswood, and Glenwood quadrangles, in Lawrence, Gallia, and Meigs counties. This work was all for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet, and was done by M. Hackett, W. H. Lovell, Basil Duke, C. W. Goodlove, W. L. Miller, W. H. Griffin, R. C. McKinney, D. C. Harrison, W. C. Hall, C. H. Birdseye, J. M. Whitman, H. L. McDonald, J. I. Gayetty, J. R. Eakin, W. H. S. Morey, C. F. Eberly, and R. H. Reineck. In all there were mapped 3,500 square miles, in connection with which 507 miles of primary levels were run and 186 permanent bench marks were established.

Pennsylvania.—The State Survey Commission of Pennsylvania allotted $14,000 for cooperative topographic surveys in that State and the Director of the Federal Survey allotted a like sum for the same purpose. The survey of the following quadrangles was completed: Clarion, in Armstrong and Clarion counties; Linesville, in Crawford County; Middletown, in Dauphin, Lancaster, Lebanon, and York counties; New Holland, in Berks and Lancaster counties; Sewickley, in Allegheny, Beaver, and Butler counties; Warren, in Warren County; and, in addition, the Pennsylvania portion of the Port Jervis quadrangle, in Pike County. The survey of the Foxburg quadrangle, in Armstrong, Butler, Clarion, and Venango counties, was not completed. This work was all for publication on the scale of 1:62,600, with a contour interval of 20 feet, and was done by R. D. Cummin, A. C. Roberts, C. C. Bassett, Duncan Hannegan, E. B. Clark, J. W. Bagley, Gilbert Young, I. M. Flocker, W. O. Tufts, M. J. Munn, C. G. Anderson, E. W. McCrary, and B. D. Stewart. In all there were mapped 1,363 square miles of new area, in connection with which 286 miles of primary levels were run and 52 permanent bench marks were established. In addition, Mr. Flocker resurveyed 105 square miles of the Johnstown quadrangle.

Tennessee.—The survey of the Woodbury quadrangle, in Cannon, Wilson, Rutherford, and Dekalb counties, was completed by Oscar Jones. The area surveyed was 242 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Messrs. Jones and Berry also commenced the survey of the Ducktown Special quadrangle, mapping 14 square miles in Polk County for publication on the scale of 1:24,000, with a contour interval of 20 feet. For the control of the Woodbury and Franklin quadrangles 73 miles of primary levels were run, and 15 permanent bench marks were established.

Virginia.—The survey of the Fort Monroe Special quadrangle, for publication on the scale of 1:24,000, with a contour interval of 10 feet, and of the Hampton quadrangle, for publication on the scale of 1:62,500, with a contour interval of 10 feet, was completed by Albert Pike, J. S. B. Daingerfield, and R. L. Harrison. The area surveyed was all in Elizabeth County. The mapping of the Natural Bridge quadrangle, in Botetourt and Rockbridge counties, was completed by Messrs. Pike and Harrison, Van H. Manning, W. H. S. Morey, and Fred Graff, jr., for publication on the scale of 1:62,500, with a contour interval of 50 feet. The total new area surveyed was 62 square miles on the 1:24,000 scale and 304 square miles on the 1:62,500 scale, in connection with which 47 miles of primary levels were run and 25 permanent bench marks were established.

West Virginia.—The State geologist of West Virginia allotted $15,000 for cooperative topographic surveys and the Director of the Federal Survey alloted an equal sum for the same purpose. The following quadrangles were completed: Kenna, in Jackson, Kanawha, Mason, Putnam, and Roane counties; Otter, in Braxton, Calhoun, Clay, Kanawha, and Roane counties; Parsons, in Preston, Randolph, and Tucker counties; Walton, in Clay, Roane, and Kanawha counties; Winfield, in Jackson, Mason, and Putnam counties; and, in addition, the West Virginia portion of the Athalia, Point Pleasant, Ravenswood, and Glenwood quadrangles, in Cabell, Mason, and Jackson counties. All the work in West Virginia was for publication on the scale of 1:62,500, with contour intervals of 20 and 50 feet, and was done by J. M. Whitman, J. R. Eakin, E. I. Ireland, J. I. Gayetty, C. F. Eberly, and R. H. Reineck. The total area mapped was 1,544 square miles, in connection with which 306 miles of levels were run and 85 permanent bench marks were established.

Wisconsin.—Portions of the Cross Plains, Sparta, and Winona quadrangles, in Dane, La Crosse, Monroe, Buffalo, and Trempeleau counties, were mapped by Robert Muldrow and A. T. Fowler, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The total area mapped was 272 square miles, in connection with which 38 miles of primary levels were run and 15 permanent bench marks were established. For the revision of the Oconomowoc quadrangle 72 miles of primary levels were run and 15 permanent bench marks were established.

DRAINAGE SURVEYS IN MINNESOTA.

An appropriation of $15,000 was made by Congress in the Indian act for the survey of the swamp areas in the ceded lands of the Chippewas in Red Lake County, Minn. This appropriation was to be expended under the Secretary of the Interior, who directed that this work be done by the Geological Survey. A. P. Meade was detailed for this purpose. Approximately 600 square miles were covered with a network of levels and the swamp area was thus mapped. In addition a line of precise levels, 71 miles in length, was run by C. H. Semper from Crookston northeastward. Sufficient data were obtained to make estimates in regard to the drainage of the Mud Lake district, and these data were assembled early in the winter by Messrs. Meade and W. C. Hall and were submitted as a report to Congress.

OFFICE WORK.

The drafting on the following sheets was completed:

Coalville, Ala.; Stilesboro, Ga.; Breese, Galatia, and Wheaton, Ill.; Waukegan, Ill.-Wis.; Waukee, Iowa; Georgetown, Lockport, and Morganfield, Ky.; Baton Rouge, La.; Lewiston, Me.; Laurel and Rockville, Md.; Pontiac and Rochester, Mich.; Florence, Miss.; Forsyth and Atlanta, Mo.; Hanover, N. H.-Vt.; Loon Lake and Potsdam, N. Y.; Goshen, N. Y.-N. J.; Port Jarvis, N. Y.-N. J.-Pa.; Beckford, Four Oaks, and Winton, N. C.; Kings Mountain, N. C.-S. C.; Ashland, Bidwell, Chillicothe, Chagrin Falls, Columbus Grove, Deshler, Middletown, New London, Ravenna, St. Henry, Warren, Waverly, West Salem, and Youngstown, Ohio; Athalia, Point Pleasant, Glenwood, and Ravenswood, Ohio-W. Va.; Clarion, Linesville, Middletown, New Holland, Sewickley, and Warren, Pa.; Woodbury, Tenn.; Fort Monroe Special, Natural Bridge, and Hampton, Va.; Kenna, Otter, Parsons, Walton, and Winfield, W. Va.

The Calhoun, Ky., and the Jackson, Miss., sheets were completely redrawn and one-half of the Wilkesville, Ohio, quadrangle.

Progress was made in the drafting of the following sheets:

Tallula, Ill., 94 per cent; Opelika, Ala., 75 per cent; Cross Plains, Wis., 63 per cent; Sparta, Wis., and Wyandotte, Mo.-Ind. T., 55 per cent each; Wilkesville, Ohio, 50 per cent; Poland, Me., 45 per cent; Providence, Ky., Mount Airy, Md., and the Ducktown Special, Tenn., 40 per cent each; Leavenworth, Kans., 25 per cent; Ray, N. Dak., 13 per cent; and Columbus, Ga., 8 per cent; while drafting was commenced on the Cooperstown, N. Y., sheet.

WESTERN DIVISION.

FIELD WORK.

SUMMARY.

Under the combined allotments from the appropriations for topography and surveying forest reserves, topographic work was done during the year in Arizona, California, Colorado, Montana, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. This resulted in the completion of the survey of 26 quadrangles and 2 special areas, in the reconnaissance survey of two large areas, and in the partial survey of 9 quadrangles, 2 special areas, and 2 reconnaissance areas. The total new area surveyed was 18,827 square miles, the surveys of 3,224 square miles being for publication on the scale of 1:62,500; those of 6,793 square miles for publication on the scale of 1:125,000; and of 8,810 square miles for publication on special scales. In addition, 803 square miles were resurveyed, of which 28 were for publication on the scale of 1:62,500; 772 were for publication on the scale of 1:125,000; and 3 were for publication on the scale of 1:6,000. In connection with this work 2,471 miles of primary spirit levels and 311 miles of precise levels were run, and 737 permanent bench marks were established.

Topographic surveys in western division from May 1, 1906, to June 1, 1907.

State.	Contour interval.	Scale of publication.				Total area surveyed.	Levels.	
		1:125,000.		1:62,500.			Distance run.	Bench marks.
		New.	Resurvey.	New.	Resurvey.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Arizona	10-20	837				[a]340	282	79
California	5-50-100	969		938	28	[b] [c]4,433	757	172
Colorado	20-50-100	681		246		[d]1,055	257	72
Montana	100	507				[c]2,359	103	22
Nevada	20-100					[b] [c]4,297	259	57
New Mexico	100	713	60			773	406	124
North Dakota	100					[c]35		
Oklahoma	20			1,024		1,024	63	21
Oregon	50-100	984				984	160	41
South Dakota	20			142		142		
Texas	20-50	629	87	677		1,393		
Utah			625			625		
Washington	20-50	1,060		197		1,257	158	37
Wyoming	100	913				913	337	112
Total		6,793	772	3,224	28	19,630	2,782	737

[a] 3 square miles resurvey in Arizona for publication on the scale of 1 : 6,000.

[b] 26 square miles in California and 42 square miles in Nevada for publication on the scale of 1 : 24,000.

[c] 2,472 square miles in California, 1,852 square miles in Montana, 35 square miles in North Dakota, and 4,255 square miles in Nevada for publication on the scale of 1 : 253,440.

[d] 128 square miles in Colorado for publication on the scale of 1 : 48,000.

DETAILS OF TOPOGRAPHIC FIELD WORK, BY STATES.

Arizona.—A portion of the Tombstone Special area, consisting of 3 square miles in Cochise County, was resurveyed for publication on the scale of 1:6,000, with a contour interval of 10 feet, this work being done by E. R. Bartlett. A line of precise levels was run from Deming, N. Mex., to Tucson, Ariz., for the control of future work, a total distance of 225 miles, in connection with which 58 permanent bench marks were established. Of this line 143 miles, with 33 bench marks, were in Arizona, the rest being in New Mexico. In the Tonto National Forest the survey of the Four Peaks quadrangle, in Maricopa and Gila counties, was completed by S. N. Stoner, for publication on the scale of 1:125,000, with a contour interval of 100 feet, the area mapped being 337 square miles. For the control of the Chiricahua National Forest 139 miles of primary levels were run by T. A. Green, in connection with which 46 permanent bench marks were established.

California.—The State Board of Examiners of California allotted $15,000 for cooperative topographic surveys in California, and the Director of the Federal Survey allotted a like sum for the same purpose. In the Sacramento Valley the survey of the Elmira, Clarksburg, Rio Vista, and Montezuma quadrangles, in Solano, Yolo, Sacramento, Contra Costa, and San Joaquin counties, was completed by A. H. Sylvester, A. B. Searle, Arthur Stiles, W. R. McKean, E. P. Davis, and C. L. Nelson. The new area surveyed was 938 square miles, in addition to which revision surveys of 28 miles, on an enlarged scale, were made in the Carquinez and Napa quadrangles. This work was for publication on the scale of 1:62,500, with a contour interval of 5 feet. The survey of the Yosemite Special area, in Mariposa County, was completed by F. E. Matthes, for publication on the scale of 1:24,000, with a contour interval of 50 feet, the area surveyed being 26 square miles. For the control of the work in California 52 miles of primary levels were run and 13 permanent bench marks were established.

In cooperation with the State of California, the survey of the Kernville quadrangle, in Kern, Tulare, and Inyo counties, consisting of 969 square miles, in the Sierra National Forest, was completed by Arthur Stiles and George R. Davis, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In connection with this work 45 miles of primary levels were run and 16 permanent bench marks were established.

For the vertical control of the Trinity National Forest 203 miles of levels were run by L. F. Biggs, in connection with which 20 permanent bench marks were established.

Colorado.—The survey of the Loveland and Fort Collins quadrangles, consisting of 246 square miles, was completed for publication on the scale of 1:62,500, with a contour interval of 20 feet; also three-fourths of the Livermore quadrangle, 460 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This work was done by Frank Tweedy. The survey of the Colorado Springs quadrangle, for publication on the scale of 1:125,000, with a contour interval of 100 feet, and of the Pikes Peak Special quadrangle, for publication on the scale of 1:48,000, with a contour interval of 50 feet, was commenced by Richard T. Evans, 221 square miles of the former and 128 square miles of the latter being completed. This work was all in El Paso and Teller counties.

The total area mapped was 1,055 square miles, and for the control of this and adjoining areas 137 miles of levels were run and 36 permanent bench marks were established.

Colorado-New Mexico.—For the control of eight quadrangles from Durango southward through San Juan County, Colo., and Rio Arriba County, N. Mex., 444 miles of primary levels were run, in connection with which 135 permanent bench marks were established. Of this, 120 miles and 36 bench marks were in Colorado, the rest being in New Mexico.

Montana.—The mapping of the Sapphire quadrangle in the Hell Gate National Forest, in Granite County, was commenced by J. F. McBeth, for publication on the scale of 1:125,000, with a contour interval of 100 feet, the area mapped being 507 square miles. In connection with this work 103 miles of levels were run and 22 permanent bench marks were established.

Montana-North Dakota.—The survey for a reconnaissance map covering portions of Dawson County, Mont., and Billings County, N. Dak., was commenced by R. H. Chapman. The area mapped was 1,887 square miles, for publication on the scale of 1:250,000, with a contour interval of 50 feet, 35 square miles being in North Dakota.

Nevada.—The survey of the Ely Special area, in White Pine County, was completed by Fred McLaughlin, for publication on the scale of 1:24,000, with a contour interval of 20 feet, the area mapped being 42 square miles.

Nevada-California.—The survey of the Las Vegas and Furnace Creek quadrangles was completed by D. F. C. Moor and J. E. Blackburn, and Mr. Blackburn also mapped a portion of the Ballarat quadrangle. This work is for publication on the scale of 1:250,000, with a contour interval of 100 feet, 4,255 square miles being in Lincoln County, Nev., and 2,472 square miles in Inyo County, Cal. For the control of these areas 630 miles of primary levels were run, in connection with which 157 permanent bench marks were established, 371 miles of levels and 100 bench marks being in California and the rest in Nevada. For the control of future mapping a line of precise levels was run from Barstow to Mohave, 86 miles in length, in connection with which 23 permanent bench marks were established.

New Mexico.—The Gallina quadrangle, in the Jemes National Forest, in Rio Arriba and Sandoval counties, was partly surveyed by J. E. Blackburn and D. F. C. Moor, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The area surveyed was 713 square miles.

Oklahoma.—The governor of Oklahoma allotted $5,000 for the continuation of cooperative topographic surveys in Oklahoma and the Director of the Federal Survey allotted a like sum for the same purpose. The survey of the Agra, Euchee Creek, Shawnee, Maud, and Sac and Fox quadrangles was completed by H. H. Hodgeson, who also mapped portions of the Prague, Asher, and Luther quadrangles, all this work being for publication on the scale of 1:62,500, with a contour interval of 20 feet. The area mapped was 1,024 square miles, in Payne, Lincoln, and Pottawatomie counties. For the control of this and other areas 63 miles of primary levels were run and 21 permanent bench marks were established.

Oregon.—The State engineer of Oregon allotted $2,500 for the continuation of cooperative topographic surveys in Oregon and the Director of the Federal Survey allotted a like sum for the same purpose. The survey of the Blalock Island quadrangle was completed by A. H. Sylvester and S. N. Stoner, for publication on the scale of 1:125,000, with a contour interval of 50 feet. The area surveyed was 835 square miles, 602 of which were in Gilliam and Morrow counties, Oreg., and 233 in Klickitat and Benton counties, Wash. For the control of this and adjacent areas 228 miles of levels were run and 60 permanent bench marks were established, 68 miles of levels and 19 bench marks being in Washington. The survey of the Mount Hood Special quadrangle, in the Bull Run National Forest, in Clackamas County, was commenced by S. N. Stoner, who surveyed 66 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Ironside Mountain quadrangle, in Baker, Malheur, Grant, and Harney counties, within the Blue Mountain National Forest, was completed by Mr. Stoner, 316 square miles being mapped for publication on the scale of 1:125,000, with a contour interval of 100 feet.

South Dakota.—The survey of the Two Top quadrangle, in Butte County, was completed by S. P. Floore, the area surveyed being 142 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Texas.—The survey of the Texarkana, Atlanta, Lindon, and Boston quadrangles, in Cass, Bowie, and Miller counties was completed by R. A. Farmer, for publication on the scale of 1:62,500, with a contour interval of 20 feet, the area surveyed being 677 square miles. The survey of the San Marcos quadrangle, in Hays, Guadalupe, Caldwell, and Gonzales counties was commenced by Fred McLaughlin and Arthur Stiles. The area surveyed was 566 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet.

Texas-New Mexico.—The survey of the La Union quadrangle, in El Paso County, Tex., was commenced by Mr. McLaughlin, the area surveyed being 63 square miles. He also did a small amount of revision work on the Las Cruces and El Paso quadrangles, this area amounting to 147 square miles. The total area surveyed was 210 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet, 150 square miles being in Texas, 63 of which is new work, and 60 square miles in New Mexico.

Utah.—The survey of the Marsh Peak quadrangle, in the Uinta National Forest, was completed by A. E. Murlin, who also commenced the mapping of the Browns Park quadrangle, the total area mapped being 625 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The work was all in Uinta County and was a resurvey of an area previously mapped.

Washington.—The survey of the Sumas quadrangle, in Whatcom County, was completed by Pearson Chapman and J. G. Hefty, for publication on the scale of 1:62,500, with a contour interval of 20 feet, the area surveyed being 197 square miles. The survey of the Zillah quadrangle, in Yakima and Klickitat counties, was completed by C. W. Sutton, for publication on the scale of 1:125,000, with a contour interval of 50 feet, the area surveyed being 827 square miles, in connection with which 90 miles of levels were run and 18 permanent bench marks were established.

Wyoming.—The survey of the Fremont Peak quadrangle, in the Yellowstone National Forest, Fremont County, was completed by T. M. Bannon and S. S. Stahl, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this and adjacent areas 337 miles of primary levels were run and 112 permanent bench marks were established. The Medicine Bow quadrangle, in the Medicine Bow National Forest, Carbon County, was completed by S. S. Stahl, the area surveyed being 42 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

OFFICE WORK.

The drafting of the following sheets was completed:

Clarksburg, Elmira, and Kernville, Cal.; Ely Special and Las Vegas, Nev.; Blalock Island, Oreg.-Wash.; Zillah and Sumas, Wash.; and Fremont Peak, Wyo.

The drafting of the plats of the boundaries of the following was completed:

Wind Cave National Park, S. Dak., and the Yosemite National Park, Cal.

Progress was made in the drafting of the following sheets: Agra, Okla., 85 per cent: Gallina, N. Mex., and Sapphire, Mont., 75 per cent: Montezuma, Cal., 70 per cent; Loveland, Fort Collins, and Livermore, Colo., Furnace Creek, Nev., Marsh Peak, Utah, Two Top, S. Dak., Texarkana and New Boston, Tex., 50 per cent; Rio Vista, Cal., 45 per cent; Yosemite Special, Cal., Pikes Peak Special, Colo., and Ironside Mountain, Oreg., 40 per cent; Glendive, Mont., 33 per cent; Mallon and Luther, Okla., 30 per cent; Ballarat, Nev., Colorado

Springs, Colo., and Sac and Fox, Shawnee, and Maud, Okla., 25 per cent; Four Peaks, Ariz., 20 per cent; La Union, N. Mex., 17 per cent; Asher and Prague, Okla., 15 per cent; Browns Park, Utah, 14 per cent; El Paso, N. Mex., 11 per cent; and Las Cruces, N. Mex., 4 per cent.

TRIANGULATION AND COMPUTING SECTION.

FIELD WORK.

EASTERN DIVISION.

The primary control work done during the season by this division remained in charge of S. S. Gannett and under the general direction of H. M. Wilson.

Primary triangulation, primary traverse, and precise leveling were carried on at various times by 9 parties. This work was distributed over portions of 18 States—Alabama, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine, Missouri, New Hampshire, North Carolina, Ohio, Pennsylvania, South Carolina, Vermont, Virginia, and West Virginia. The total area covered by this primary control was 14,600 square miles, of which 12,200 square miles were controlled by primary traverse. The result of this work was to make control available in fifty-five 15-minute quadrangles and four 30-minute quadrangles. In the progress of this work 38 triangulation stations were permanently marked and their geodetic positions determined, and 3,084 miles of primary traverse and 1,255 miles of precise levels were run, in connection with which 403 permanent bench marks were established.

Alabama.—The control of the Coalville 15-minute quadrangle, in Shelby County, was completed by C. B. Kendall, who ran 30 miles of primary traverse.

Alabama-Georgia.—Control for the Columbus quadrangle, in Russell County, Ala., and Chattahoochee and Muscogee counties, Ga., was obtained by C. B. Kendall, who ran 54 miles of primary traverse.

Florida.—For the control of the soil survey of Jefferson County 230 miles of primary traverse were run by L. E. Tucker.

Georgia.—The Eatonton and Milledgeville quadrangles, in Greene, Morgan, Putnam, Taliaferro, Baldwin, and Hancock counties, were controlled by 176 miles of primary traverse run by Mr. Kendall. A line of precise levels 39 miles in length was run from Macon to Milledgeville by C. H. Semper.

Illinois.—In cooperation with the State, control for the Galatia, Thompsonville, Waukegan, Herrin, Murphysboro, Galena, and Apple River quadrangles, in Hamilton, Saline, Franklin, Williamson, Lake, Jackson, Perry, and Jo Daviess counties, was obtained by 398 miles of primary traverse run by L. E. Tucker. A line of precise levels 142 miles in length was run by T. A. Green from Olney to Champaign through the counties of Champaign, Coles, Cumberland, Edgar, Jasper, Richland, and Vermilion. Another line of precise levels 71 miles in length was run by Mr. Green from Duquoin to Shawneetown through the counties of Franklin, Gallatin, Perry, and Saline.

Indiana.—The Bloomington, Saline City, and Terre Haute quadrangles, in Monroe, Morgan, Owen, Clay, Parke, and Vigo counties, were controlled by 225 miles of primary traverse run by J. R. Ellis. A line of precise levels 51 miles in length was run by C. H. Semper from Mitchell to Worthington.

Kentucky.—In cooperation with the State, control for the Sadieville quadrangle, in Franklin and Owens counties; for the Monticello and Burnside quadrangles, in Wayne County; and for the Clay quadrangle, in Caldwell and Crittenden counties, was obtained by 217 miles of primary traverse run by J. R. Ellis. Control for the Hazard, Grundy, and Whitesburg 30-minute quadrangles, in Breathitt, Knott, and Pike counties, was obtained by means of triangulation. Six old stations and 8 new stations were permanently marked and occupied by E. L. McNair. A line of precise levels was run by C. H. Semper from Georgetown to Louisville, a distance of 77 miles; another line, 96 miles in length, was run by W. H. Monahan from Lexington to Jackson; and a line 14 miles in length was run by T. A. Green in Crittenden County, the latter line being based on the elevation at Shawneetown, Ill., determined earlier in the season by precise levels from Duquoin, Ill.

Louisiana.—Primary traverse control for the soil surveys in Winn Parish was obtained by L. E. Tucker by means of 156 miles of primary traverse, in addition to 163 miles of primary traverse which had previously been run for the control of the Winnfield 15-minute quadrangle. A precise-level line 34 miles in length was run by E. L. McNair from Colfax to Winnfield. In cooperation with the State 218 miles of primary traverse were run by Mr. Tucker through portions of Acadia, Iberia, Lafayette, St. Mary, St. Martin, and Vermilion counties, from Morgan City to Jennings. A line of precise levels 99 miles in length was run through the same area by Mr. McNair, this line being based upon the tidal bench mark at Weeks Island and extended via Baldwin and Lafayette to Jennings.

Maine.—In cooperation with the State a line of precise levels 33 miles in length was run by N. A. Campbell from a tidal bench mark at Portland to Brunswick, and another line of precise levels, 42 miles in length, was run from Portland northwestward to the New Hampshire-Maine boundary line near Freedom.

Missouri-Kansas.—The Easton and Leavenworth 15-minute quadrangles were controlled by a line of primary traverse 106 miles in length, run by G. T. Hawkins.

Missouri-Indian Territory.—The Wyandotte 30-minute quadrangle, in Cherokee Nation, Ind. T., and in McDonald and Newton counties, Mo., was controlled by Mr. Hawkins, who ran 72 miles of primary traverse.

New Hampshire-Vermont.—A line of precise levels 130 miles in length was extended by N. A. Campbell from the vicinity of Freedom, N. H., to Whiteriver Junction, Vt., passing through the counties of Belknap, Carroll, and Grafton, N. H., and Windsor, Vt.

Ohio.—In cooperation with the State twelve 15-minute quadrangles, covering portions of the counties of Hocking, Jackson, Vinton, Fairfield, Pickaway, Carroll, Coshocton, Holmes, Tuscarawas, Wayne, Crawford, Huron, Richland, and Seneca, were controlled by 406 miles of primary traverse run by J. R. Ellis. A line of precise levels 50 miles in length was run by W. H. Monahan from Chillicothe to Portsmouth through the counties of Pike, Ross, and Scioto. Another line, 135 miles in length, was run by Mr. Monahan from Columbus eastward to Uhrichsville, through the counties of Fairfield, Guernsey, Muskingum, Perry, and Tuscarawas; and a third line, 89 miles in length, was run by C. H. Semper from Ottawa westward and northward to Defiance and thence eastward to Tontogany.

North Carolina-South Carolina.—Control for the Gaffney and Kings Mountain quadrangles, in Cleveland and Gaston counties, N. C., and Cherokee and York counties, S. C., was obtained by 135 miles of primary traverse run by C. B. Kendall.

Pennsylvania.—In cooperation with the State additional control for the Valier quadrangle, in Indiana and Jefferson counties, for the Arendtville, Newville, and Gettysburg quadrangles, in Adams and Cumberland counties, and for the Bedford quadrangle, in Bedford County, was obtained by G. T. Hawkins, who located 17 triangulation stations. The Butler and Zelionople quadrangles, in Butler County, were controlled by 108 miles of primary traverse run by C. B. Kendall.

Tennessee.—Control for the Woodbury, Franklin, and Jackson quadrangles, in Cannon, Rutherford, Williamson, Madison, Chester, Henderson, and Decatur counties, was obtained by Mr. Kendall, who ran 373 miles of primary traverse. A line of precise levels 58 miles in length was extended by T. A. Green from Nashville eastward through the Woodbury quadrangle.

Virginia.—The Buchanan and Fincastle quadrangles, in Botetourt and Rockbridge counties, were controlled by Oscar Jones, who located 4 triangulation stations. A line of precise levels 60 miles in length was run by N. A. Campbell from Buchanan northwestward along the Chesapeake and Ohio Railway to a point near Allegheny station.

West Virginia.—In cooperation with the State the control for the Elkins quadrangle, in Barbour and Randolph counties, was completed by E. L. McNair, who located 3 triangulation stations.

WESTERN DIVISION.

Triangulation was carried on at various times during the year by 9 parties and primary traverse by 1 party, under the direction of E. M. Douglas. The work was distributed over portions of 9 States and Territories—Arizona, California, Colorado, Montana, New Mexico, Oklahoma, Oregon, Utah, and Washington. The total area covered by this primary control was 25,400 square miles, of which 250 square miles were controlled by primary traverse. The result of this work was to make control available in six 15-minute quadrangles, nineteen 30-minute quadrangles, and one special area. In the progress of this work 243 new triangulation stations were selected, permanently marked, and their geodetic positions determined, and 72 miles of primary traverse were run.

Arizona.—In order to control the Chiricahua National Forest triangulation was extended by T. M. Bannon over an area of 6,000 square miles in southeastern Arizona. In this work 48 points were located, in the counties of Cochise, Graham, Pima, and Santa Cruz.

California.—In cooperation with the State, four 15-minute quadrangles, in the counties of Contra Costa, Sacramento, Solano, San Joaquin, and Yolo, were controlled by C. F. Urquhart, who located 42 triangulation stations. Reconnaissance triangulation in the Trinity National Forest was extended by A. I. Oliver over an area of 1,000 square miles in Siskiyou and Trinity counties, but owing to extremely unfavorable weather, observations were not completed at the close of the season of 1906.

Colorado.—The Eatonton quadrangle, in Larimer County, was controlled by Frank Tweedy, who located 6 triangulation stations. In connection with the extension of triangulation in Archuleta, Hinsdale, and La Plata counties, the control for the San Juan National Forest was completed by H. L. Baldwin, jr.

Colorado-New Mexico.—An area of 2,700 square miles in Archuleta, Hinsdale, and La Plata counties, Colo., and 3,200 square miles in Rio Arriba and San Juan counties, N. Mex., was controlled by 47 triangulation points located by H. L. Baldwin, who also furnished control for the Jemes and adjacent national forests.

Montana.—The Glendive one-degree quadrangle, mostly in Dawson County, Mont., but a small part in Billings and McKenzie counties, N. Dak., was controlled by 13 triangulation points located by R. H. Chapman.

Nevada.—Additional control for the Las Vegas one-degree quadrangle, in Lincoln County, was obtained by B. D. Stewart, who located 9 points by triangulation. The Ely Special area, in White Pine County, was controlled by Fred McLaughlin, who located 14 secondary triangulation points.

Oklahoma.—In cooperation with the Territory, one 15-minute quadrangle, in Lincoln County, was controlled by locating 24 points by triangulation, and one quadrangle in Pottawatomie County was controlled by means of 72 miles of primary traverse. The field work was done by H. H. Hodgeson.

Oregon.—In cooperation with the State the portion of the Blalock Island quadrangle that lies within Morrow County was controlled by 4 triangulation points located by C. F. Urquhart and A. I. Oliver. The Mount Hood Special area, in the Bull Run National Forest, was controlled by 9 triangulation points located by Mr. Urquhart.

Washington.—An area of 3,000 square miles in Benton, Franklin, Klickitat, and Wallawalla counties was controlled by means of 27 triangulation points located by Messrs. Urquhart and Oliver.

OFFICE WORK.

The office computations of triangulation, primary traverse, and adjustment of level circuits were continued in charge of S. S. Gannett until the reorganization of the topographic branch on March 19, when E. M. Douglas was placed in charge. The results of primary triangulation and primary traverse in 27 States were summarized and published in Bulletin No. 310. The triangulation and leveling plats of all States were brought up to date, as well as the card catalogue of triangulation and primary-traverse stations. The preparation of triangulation and leveling data for chiefs of field parties and in reply to requests of persons not connected with the Survey required the time of a considerable portion of the office force.

During the year the following results were computed by members of the topographic branch, detailed from time to time for office computing:

EASTERN DIVISION.

Alabama.—For the control of the Coalville quadrangle, in Shelby County, 370 latitudes and departures and 36 geographic positions were computed. Level circuits in the same area were adjusted. For that portion of the Columbus, Ga., quadrangle which lies within Russell County, Ala., 125 latitudes and departures and 23 geographic positions were computed.

Florida.—For the control of the soil survey map of Jefferson County, 930 latitudes and departures and 105 geographic positions were computed.

Georgia.—For the Columbus, Eatonton, Milledgeville, and portions of adjoining quadrangles, 1,530 latitudes and departures and 217 geographic positions were computed. The office computation of the precise-level line from Macon to Milledgeville was completed.

Illinois.—Latitudes and departures to the number of 1,671 and 369 geographic positions were computed for the control of 7 quadrangles in the counties of Franklin, Hamilton, Saline, Williamson, Lake, Perry, and Jo Daviess. Level circuits in the same area were adjusted and the office computation of the precise-level lines Duquoin to Shawneetown and Olney to Champaign was completed.

Indiana.—For the Bloomington, Saline City, and Terre Haute quadrangles, in Monroe, Morgan, Clay, Owen, Parke, and Vigo counties, 1,229 latitudes and departures and 194 geographic positions were computed. The office reduction of the precise-level line Mitchell to Bedford was also made.

Kentucky.—The geodetic positions of 8 triangulation stations in Breathitt, Knott, and Pike counties, and 2,105 latitudes and departures and 160 geographic positions in Wayne, Franklin, Owen, Caldwell, and Crittenden counties were computed. Level circuits were adjusted in the Frankfort, Lockport, Burnside, Monticello, and Clay quadrangles. The office reduction of the precise-level lines from Georgetown to Louisville and from Lexington to Jackson was completed.

Louisiana.—For the Winnfield 15-minute quadrangle and for the remaining part of Winn Parish 2,092 latitudes and departures and 162 geographic positions were computed. Latitudes and departures to the number of 460 and 110 geographic positions in Acadia, Iberia, Lafayette, St. Mary, St. Martin, and Vermilion parishes were computed and office reduction of the precise-level line through the same parishes was made.

Maine.—The office reduction of the precise-level line in Cumberland and Oxford counties was made, and circuits of primary levels in the Lewiston and Poland quadrangles were adjusted.

Maryland.—Primary-level circuits were adjusted for Montgomery and Carroll counties.

Minnesota.—The office computation of the precise-level line in the ceded lands of the Chippewas, Red Lake County, was completed, and circuits of primary levels in the same area were adjusted.

Kansas-Missouri.—For the Leavenworth quadrangle, in Platte County, Mo., and Leavenworth County, Kans., and the Easton quadrangle, in Jefferson and Atchison counties, Kans., 580 latitudes and departures and 90 geographic positions were computed. Primary-level circuits in the same area were adjusted.

Missouri-Kansas-Oklahoma.—Primary-level circuits in No. 2 County, Okla., Newton and McDonald counties, Mo., and Cherokee County, Kans., in the Wyandotte 30-minute quadrangle, were adjusted, and 690 latitudes and departures and 56 geographic positions were computed.

New Hampshire-Vermont.—The office reduction was made of the precise-level line in Belknap, Carroll, and Grafton counties, N. H., and Windsor County, Vt. Primary-level circuits in the Winnepesaukee quadrangle, New Hampshire, were adjusted.

North Carolina-South Carolina.—Primary-level circuits were adjusted in the Gaffney and Kings Mountain quadrangles, and 1,060 latitudes and departures and 144 geographic positions, controlling these quadrangles, were computed.

Ohio.—For 12 quadrangles in the counties of Hocking, Jackson, Vinton, Fairfield, Pickaway, Carroll, Coshocton, Holmes, Stark, Tuscarawas, and Wayne, 2,044 latitudes and departures and 332 geographic positions were computed. The office reduction of the precise-level lines Chillicothe to Portsmouth, Columbus to Uhrichsville, and Ottawa to Tontogany was made, and primary-level circuits in the following counties were adjusted: Franklin, Fairfield, Ross, Pike, Scioto, Defiance, Henry, Lucas, Paulding, Harrison, Jefferson, Carroll, Columbiana, and Portage.

Pennsylvania.—The geodetic positions of 17 triangulation stations, 745 latitudes and departures, and 100 geographic positions of primary-traverse stations in Bedford, Butler, Adams, Cumberland, Indiana, and Jefferson counties were computed. Level circuits in parts of the same counties were adjusted.

Tennessee.—Computations of 2,481 latitudes and departures and 372 geographic positions were made in the Franklin, Jackson, and Woodbury quadrangles. The office reduction of the precise-level line Nashville to Woodbury was completed.

Virginia.—The geodetic positions of 4 triangulation stations in Botetourt and Rockbridge counties were computed, and the office reduction of the precise-level line Buchanan to Alleghany station was completed.

West Virginia.—The geodetic positions of 3 triangulation stations in Barbour and Randolph counties were computed, and primary-level circuits in Mason, Jackson, Putnam, and Roane counties were adjusted.

WESTERN DIVISION.

Arizona.—The office reduction of the precise-level line from the Arizona-New Mexico line to Tucson was made, and all level circuits in the Territory were readjusted and the elevations of bench marks reduced to mean sea-level datum.

California.—The geodetic positions of 42 triangulation stations in Contra Costa, Sacramento, Solano, San Joaquin, and Yolo counties were computed. All circuits of levels in the State were adjusted, the elevations of bench marks were reduced to mean sea level, and the results were prepared for publication as a bulletin.

Colorado.—The geodetic positions of 6 triangulation stations in Larimer County and of 18 stations in Archuleta, Hinsdale, and La Plata counties were computed, and level circuits in the same counties were adjusted.

Montana.—The geodetic positions of 12 triangulation stations in Dawson County were computed, and level circuits in Fergus County were adjusted.

New Mexico.—The geodetic positions of 26 triangulation stations in Rio Arriba and San Juan counties were computed, and level circuits in the same counties were adjusted. The office reduction of the precise-level line from Deming to the Arizona line was completed.

Nevada.—The geodetic positions of 14 secondary triangulation points in White Pine County were computed.

Oklahoma.—The geodetic positions of 15 triangulation points and the geographic positions of 63 primary-traverse points in Lincoln and Pottawatomie counties were computed, and primary-level circuits in the same counties were adjusted.

Oregon.—The geodetic positions of 9 triangulation stations controlling the Mount Hood Special quadrangle were computed.

Oregon-Washington.—The geodetic positions of 31 triangulation stations in Morrow County, Oreg., and Benton, Klickitat, Franklin, Yakima, and Wallawalla counties, Wash., were computed, and level circuits in the same area were adjusted.

Wyoming.—Level circuits throughout the State were readjusted, elevations of bench marks corrected to mean sea level, and the results arranged for publication.

SECTION OF INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

During the field season inspection of topographic mapping, complete or in progress, was carried on by John H. Renshawe in the eastern part of the United States. The purpose of this work was the maintenance of uniformity of style and system in the expression of topographic features. All topographic parties in States east of Mississippi River were visited and given instruction.

During the office season careful attention was given to the final drawing of map sheets, for the purpose of eliminating personal characteristics and errors of expression. Attention was also given to the preparation of material for revision of the base map of the United States.

SECTION OF INSTRUMENTS AND TOPOGRAPHIC RECORDS.

During the year the usual custom of making a general overhauling of all instruments was continued. This work was done in the shop of the Survey, except when extensive repairs, beyond its capacity, were required, when the instruments were sent to the makers. Purchases were made from time to time to cover losses sustained by wear and tear in the field. Ten telescopic alidades, with special stadia attachment, were bought, as the experiments of the previous year proved that this attachment was most useful. Experiments were continued with solar alidades, with the view of adapting an instrument of this class to topographic work.

The filing of the original records under the existing card system was continued. The number of such pieces filed was about 1,500, comprising triangulation, level, and topographic notebooks and plane-table sheets. In addition, about 100 pieces of miscellaneous material were catalogued for filing.

DIVISION OF GEOGRAPHY AND FORESTRY.

The division was continued under the direction of Henry Gannett. The principal results were as follows:

The revision of the three-sheet map of the United States on a scale of 1:2,500,000 was continued and good progress was made.

The preparation of sheets, as part of the world-map scheme, on a scale of 1:1,000,000 was continued. Seven such sheets have been projected, and all available surveyed material has been added to them. Separate maps of Wyoming, Utah, Colorado, Arizona, New Mexico, West Virginia, Virginia, Maryland, and Delaware have been drawn, embodying all available surveyed material.

Preparation of maps of the national forests has been continued in the form of township plats. These plats were at first made on a scale of 2 inches to the mile, and each township was published as an individual map. In order to meet better the needs of the Forest Service the scale was afterwards changed to 1 inch to the mile, and six townships are published together on an atlas sheet, on which is shown the land, timber, and alienation classification by color and by symbols. Additions to national forests which had been completed necessitated many changes in the manuscripts.

The preparation of "The areas of the United States, the States, and the Territories," published as Bulletin No. 302, which is the result of cooperation between the Census Office, the General Land Office, and the Geological Survey, is an attempt to bring the figures of areas into accord.

The "Manual of topographic methods" was prepared and published as Bulletin No. 307.

A list and descriptions of 100 atlas sheets illustrating topographic forms was prepared and published.

The preparation of gazetteers of New York and California was well advanced.

Mr. Gannett continued as chairman of the Geographic Board. Much work was done for this organization in the preparation of lists of all towns in the United States where the post-office name differs from the town name—a matter that has been taken up with the Post-Office Department—and in the preparation of sheets showing different conventional symbols used by Government offices for the representation of the same object. An effort will be made to have one set of symbols adopted for Government use.

CREDIT FOR SUGGESTIONS.

During the fiscal year the following useful suggestions pertaining to topographic work were adopted with advantage to the Survey:

L. F. Biggs, levelman, suggested a useful method for checking rod readings, adapted to the yard rods used with precise-level lines, consisting of a series of graduations in feet on the back of the rods.

A. O. Burkland, assistant topographer, suggested a combination of the short-sight alidade with the ordinary boxwood plotting scale, the resulting device being a sight alidade at one-half the cost of the all-metal instrument and also a convenient plotting scale.

H. L. Baldwin, jr., topographer, proposed a plan whereby primary or secondary traverse lines could be plotted more accurately than by methods previously in use, the method being to plot the traverse on ten times the desired scale on a separate piece of paper placed near the proper place of the traverse on the map, and then to connect the terminal or controlling points of the large-scale traverse by a straight line which can be readily transferred to the proper place on the map by means of two triangles and at the same time reduced in length to its proper scale by dividing its length by ten.

Glenn S. Smith, topographer, proposed a movable arm for holding the compass on a traverse plane-table board, which permits easy adjustment for changed declinations.

WATER-RESOURCES BRANCH.

ADMINISTRATION.

During the last year some radical changes were made in the methods of carrying on the work and in the administration of the water-resources branch. The former " hydrographic " branch was composed of three divisions—the hydrographic, the hydrologic, and the hydro-economic. The first named measured stream flow, the second investigated underground waters, and the third determined the quality of water, the variation that takes place in its constituents, and the effect of the variation on the usefulness of the water. These three divisions had many things in common, and there resulted some duplication of work and more or less complication in administration. Therefore, at the beginning of the last fiscal year, these divisions were abolished and the common features of the work were consolidated, so that duplication would be avoided and the needs of one investigation be closely harmonized with those of another.

At the beginning of the last fiscal year it was necessary also to rearrange and reduce the work, because of the reduction in the appropriation made by Congress, which amounted to 25 per cent. After careful consideration, it was decided that instead of making a uniform reduction along all lines of work, it would be better to study the needs or demands in each part of the country and reduce or discontinue in each region that work which seemed to be least important. It was clear, for example, that in the arid West the work of greatest importance is the measurement of stream flow for the determination of the amount of water available for irrigation; in the Mississippi Valley, broadly speaking, the work of greatest importance is the study of stream flow for purposes of flood control and navigation and the study of underground water and the determination of its quality; while in the eastern part of the United States the measurement of stream flow again assumes greatest importance.

The work was carried on under the direction of M. O. Leighton, acting chief hydrographer until February 1 and chief hydrographer thereafter, assisted by N. C. Grover, assistant chief hydrographer, until April 1, and by John C. Hoyt, assistant chief hydrographer, thereafter.

STREAM-FLOW MEASUREMENTS.

New York and New England district.—In this district there were 94 stream-measurement stations maintained, and, in addition, river-profile surveys were made in cooperation with the State Survey Commission of Maine under the appropriation made by the legislature for this purpose. These surveys included the determination of the storage capacity available in the drainage basins of Wood and Attean ponds and Brassua Lake, and the area of Holeb, Long, Lower and Middle Roach, West Carry, and Spencer ponds and Flagstaff and Spring lakes. Profile surveys of Androscoggin River, which had been completed from tide water to Livermore Falls, were carried from Livermore Falls to Errol dam, at the outlet of Umbagog Lake. The amount appropriated by the State of Maine for the cooperative work was $3,500.

A report on the hydrography of the Kennebec River basin, dealing with stream flow, quality of water, sewage pollution, water power, and water storage, was completed in the early part of the year and forwarded for publication. This will soon appear as

Water-Supply and Irrigation Paper No. 198. The district was under the charge of H. K. Barrows.

The State engineer of New York, under authority granted by the legislature, cooperated in the maintenance of stream-measurement stations in New York to the extent of $1,500. Assistance and advice were also received from the State water supply commission, the barge canal commission, and the additional water supply commission of the city of New York, for all of which it is desired to return acknowledgments.

Middle Atlantic States district.—This district covers Pennsylvania, New Jersey, Maryland, Virginia, and West Virginia. There were 61 stations maintained, but as most of them are well rated numerous visits thereto for the purpose of making measurements were not required, and the greater part of the work consisted of observation of gage heights. Beginning April 1, 1907, by reason of the great reduction made in the appropriation for the work of the branch, the expenses of maintenance of river stations in Pennsylvania, including the pay of gage readers and the traveling expenses of Survey engineers, were temporarily assumed by the State water supply commission of Pennsylvania, in the hope that later appropriations may be sufficient to enable the Federal Survey to resume its original work. The supervision of the work and the computations and office work necessary in connection with the publication of the results are to be maintained throughout the fiscal year by the Survey.

The work at the measurement stations maintained in Maryland, except a few in the upper Potomac basin, received the aid of the State geologist, who assumed the payment of gage readers. The work in this district was under the charge of N. C. Grover.

South Atlantic States district.—There were 118 flow-measurement stations maintained in this district, which covers all the Atlantic and Gulf States from North Carolina to Louisiana, inclusive, and also Tennessee. This is one of the most important stream-measurement districts in the country, and the industrial development along the rivers resulting from the work of the Geological Survey has been greater than in any other part of the United States except in the arid West. The work in this district was under the charge of M. R. Hall.

Central States district.—Stream-flow measurements in the Central States were largely discontinued except in Michigan, Wisconsin, and Minnesota, because it was believed that greater benefit would be secured in the remaining States by the investigation of underground-water resources. In the three States mentioned 30 river stations were maintained. In addition, profile surveys were made in Wisconsin, in cooperation with the Geological and Natural History Survey of the State, L. S. Smith, engineer, under an appropriation of $2,500 made by the legislature for that purpose. The stream-measurement work in this district was under the charge of Albert H. Horton.

Missouri River district.—This district comprises North Dakota, South Dakota, Montana, and northern Wyoming. There were 81 stations maintained, and the work was largely devoted to the measurement of streams available for irrigation. Cooperation was secured with the United States Reclamation Service in the maintenance of stations connected with irrigation projects actually under construction. The work in this district was under the charge of Robert Follansbee.

Nebraska.—The work in this State was carried on in cooperation with the State engineer, who performed all the field work necessary to maintain 10 stations. The expenses, exclusive of the services of the State engineer, were equitably divided.

Denver district.—This district comprises Colorado, southern Wyoming, and eastern Utah. Fifty-eight stations were maintained, largely to obtain data in connection with irrigation. The headwaters of many of the most important streams of the United States are located in this district, which makes it a critical point for the accurate observation of stream flow. The work in this district was under the charge of R. I. Meeker.

Texas.—In this State 27 stations were maintained. The work in Texas, having been carried on for an extended term of years, may be considered practically finished. The measurements have been made under the direction of T. U. Taylor.

New Mexico.—This district comprises New Mexico and Oklahoma. Twenty-seven stations were maintained, largely for purposes of irrigation. The United States Reclamation Service cooperated in the maintenance of measurement stations connected with projects under construction. The work in this district was directed by W. A. Lamb.

Great Basin district.—This district comprises Idaho, Utah, and Nevada. Forty-one stations were maintained. The United States Reclamation Service cooperated in the maintenance of project stations in all three of these States, while additional cooperation was rendered by the State engineer of Nevada. The work in this district was under the charge of E. C. La Rue.

Columbia River district.—The possibilities of water-supply development in this district, which comprises Washington and Oregon, are not yet properly appreciated, and years must elapse before investigations can be carried sufficiently near to completion to show the enormous resources of this region. During the last fiscal year 28 measurement stations were maintained in Washington and 51 in Oregon, the work in the latter State being carried on in cooperation with the State engineer, to whom acknowledgment is made for excellent services. The Reclamation Service also cooperated in the maintenance of project stations. The work in this district was under the charge of J. C. Stevens.

California district.—The work in this district was carried on in cooperation with the State of California under a liberal appropriation made by the legislature in response to the demand of citizens of the State who realize that industrial development is largely dependent upon the proper examination of water resources. There were 70 stations maintained, and in addition observations and surveys were made looking to the diffusion of information concerning the conservation of water supplies. The work in this district was under the charge of W. B. Clapp.

The total number of stations maintained by the water-resources branch during the last fiscal year was 686.

UNDERGROUND-WATER INVESTIGATIONS.

Investigations of underground water comprise the geologic study of water-bearing strata, the depth at which they occur beneath the surface, the amount and character of water available and its usefulness in irrigation and for domestic and industrial supplies.

Maine, south of the forty-ninth parallel.—A study of the depth of currents and the amount and character of the deep-seated waters in the granite of the State was conducted by F. G. Clapp.

Connecticut.—A study of the underground waters, similar in all respects to that in Maine, was conducted by H. E. Gregory.

Coastal plain of Virginia and North Carolina.—A study of the artesian waters derived from the uplands of the Appalachian region and flowing beneath the surface at varying depths on the broad, low plain adjoining the coast was conducted by Samuel Sanford and Bertrand L. Johnson, under the direction of M. L. Fuller.

Blue-grass region of Kentucky.—A study of the upper and the deep-seated waters in the various formations in this region, the origin and immediate sources of which are obscure, was conducted by George C. Matson.

Iowa and southeastern Minnesota.—This study consisted of locating and exactly defining the sources of artesian water beneath this great area, former observations concerning which had been confusing. One of the most important features of this investigation was the study of the character of the water and its variation from month to month in the same well or series of wells. In heavily mineralized waters, such as occur in this region, the consistent study of these variations is highly important from all practical standpoints. This work was conducted under the direction of W. H. Norton, M. L. Fuller, and W. S. Hendrixson.

Sun River Valley of Montana.—A study of the very important artesian basin in the vicinity of Great Falls, Mont., was conducted by C. A. Fisher.

Beaver Valley, Utah.—A study of artesian waters in Beaver County, Utah, similar in many respects to that of Sun River Valley in Montana, was conducted by W. T. Lee.

Southern foothill belt of California.—This is an important agricultural region east of the southern coastal plain, in which a knowledge of the currents of underground waters for irrigation is most important. The work was conducted by W. C. Mendenhall.

Underground waters of Lake County, Oreg.—This work was conducted under the direction of W. C. Mendenhall.

Other areas.—Investigations similar to the above were carried on but not fully completed in the Triassic area of New York, New Jersey, and Pennsylvania; in the northern portion of Florida; in Ohio and Indiana; in the northeastern portion of Texas; and in the San Joaquin Valley of California.

In addition to the work mentioned in the foregoing paragraphs, reports of investigations were completed and forwarded for publication as follows:

Flowing wells in the southern peninsula of Michigan, by Frank Leverett.

Geology and water resources of the western Panhandle of Texas, by C. N. Gould.

Underground waters of the coastal plain of Texas, by T. U. Taylor.

Water resources of the Rio Grande Valley of New Mexico, by W. T. Lee.

The underflow of the South Platte Valley in Nebraska, by C. S. Slichter and H. C. Wolf.

Geology and water resources of Owens Valley, California, by W. T. Lee.

Underground waters of western Tennessee and Kentucky, by L. C. Glenn.

Underground-water resources of Mississippi, by A. F. Crider.

Preliminary report on the Roswell artesian area, New Mexico, by C. A. Fisher.

Underground waters of Utah Lake and Jordan River valleys, by G. B. Richardson.

INVESTIGATIONS OF QUALITY OF WATER.

In making a study of water resources it is necessary to consider the character of the water, because its usefulness is directly dependent on the minerals it contains. A water used for irrigation should not contain an overabundance of salts, since an excess of these is a detriment to crops. The amount and character of suspended matter carried by waters used for irrigation are important, because in some regions the sediment is of value as a fertilizer. Suspended matter is also of prime importance in connection with navigation, because it must be considered in connection with questions of channel maintenance and silting, as well as with decisions as to channel capacity, slope, etc. The study of the quality of water is also of great importance in connection with its usefulness for manufactures and public supplies; and, in general, considerations of the character of water are in many cases more important than considerations of quantity.

For the purpose of determining in the most comprehensive way the character of the waters in various parts of the United States, especially surface waters, sampling stations have been established on the more important rivers of the country and the samples collected are sent daily from these points to the various laboratories maintained under the direction of the water-resources branch. At these laboratories the samples have been analyzed, and the records show the character of the water and its variation from day to day, giving valuable and necessary data concerning the practical usefulness of the water under observation. Laboratories have been maintained at Washington, D. C.; Norfolk, Va.; Athens, Ga.; and Iowa City, Iowa. To the authorities of the University of Georgia and the State University of Iowa acknowledgments are due for gratuitously providing suitable quarters for the establishment of the laboratories. Work of similar character has been performed, under cooperation with the State water survey, State geological survey, and State experiment station of Illinois, in the laboratory of the first-named survey at Urbana, Ill. Similar investigations have been made in cooperation with the State of Kansas and the State University of Kansas at Lawrence; also in cooperation with the State board of examiners of California, quarters for the laboratory having been furnished by the authorities of the University of California at Berkeley. This work has been under the general direction of R. B. Dole, assisted by H. N. Parker, W. D. Collins, Walton Van Winkle, Edward Bartow, and others.

In addition to the work above described, analyses have been made in connection with ground-water investigations. The samples collected are representative of conditions normally occurring in the various regions under investigation. From the results collected there will be prepared reports on the best methods of utilizing these waters. In connection with this work investigations have been made of the effects of certain wastes on the waters of the country and the damage caused by them. Such work has been carried on in cooperation with the Massachusetts Institute of Technology at Boston, under the direction of Earle B. Phelps, and also in cooperation with the State board of health of Rhode Island, under the general direction of Herman Stabler.

TECHNOLOGIC BRANCH.

ORGANIZATION.

The technologic branch includes the division of fuels and the division of structural materials.

The creation of this new branch did not involve any radical change of the organization that formerly existed in the fuel-testing plant and the structural-materials testing laboratories in Forest Park, St. Louis, Mo.

In pursuance of an order of the Secretary of the Interior, the technologic branch organized its administrative office in Washington, D. C., on April 2, 1907, the official headquarters of both divisions above named having before that time been at St. Louis. The permanent organization in Washington embraces the expert in charge, Joseph A. Holmes, the chief engineer, H. M. Wilson, who in the absence of the expert in charge assumes his duties, the editorial assistants, and the general clerical force engaged on the correspondence, records, supplies, shipments, accounts, and bibliography. From the Washington office directions are issued in respect to the investigations, tests, field work, and other operations of the officers and employees in different parts of the country.

FUELS DIVISION.

The investigations of the fuel resources of the United States and the analyzing and testing of the coals, lignites, peats, mineral oils, and other mineral fuels belonging to and for the use of the United States, in order to determine their fuel value, which were begun in 1904 under the authority of Congress, were continued during the year at the fuel-testing plant in St. Louis.

During March, April, May, and June of the present year, as the work of the various sections would permit, the boiler, producer, and briquetting sections of the fuel-testing plant were removed from St. Louis to Norfolk, Va., for testing coals for naval uses; the coking and coal-washing sections to Denver, Colo., for testing coals from the public lands; and the chemical laboratories to Pittsburg, Norfolk, Washington, and Denver, for the analysis of coals sent in from the different Government stations.

The work of the fuels division has been divided into sections, as follows:

CHEMICAL SECTION.

In this section are made all analyses and calorimetric determinations of fuels, samples of which are submitted therefor, including the analysis and laboratory testing of the coals used by the Government. This section also investigates the chemistry and physics of the combustion of fuels, the heating value of the various fuels and methods of determining the same, the by-products obtainable in the coking of coals, mainly from public lands of the West, the physical and chemical composition of the various fuels and of the products of combustion at various temperatures, and kindred problems. N. W. Lord, professor of metallurgy and mineralogy at Ohio State University, continued to direct the work of this section.

Laboratories were provided and equipped in St. Louis for the work of this section, and during the period covered by this report about 1,400 samples were received in the laboratory. Proximate analyses and determinations of sulphur were made upon all of them, and upon a large number of the samples ultimate analyses and determinations of the heating value were made. These tests, together with other analyses of special materials, involved more than 7,000 determinations.

In addition to the regular work on fuels, about 100 samples of pig iron from the cupola tests on cokes were analyzed for silicon, sulphur, and manganese, with a view to determining the influence of the coke made from coals owned by the Government on the quality of the pig iron.

Research analyses and high-temperature measurements of the products of combustion will be made at Norfolk. The principal laboratory for coal analyses and experimental work and for by-product investigations has been established at Pittsburg. A small laboratory is maintained at Washington for sampling the coals purchased by the Government Departments in the city.

STEAM-ENGINEERING SECTION.

In this section are conducted investigations for determining the most efficient method of burning coal in the heating and power plants of the Government in different parts of the country, including investigations looking to the minimum production of smoke and comparative tests of various coals under similar and different types of boilers. L. P. Breckenridge, professor of mechanical engineering at the University of Illinois, continued to supervise the work of this section, W. T. Ray being in immediate charge as engineer of tests. The section operated during the preceding fiscal year two 210-horsepower boilers with different equipment for firing, etc., and conducted 118 boiler tests.

In April the equipment was removed from St. Louis to Norfolk, Va., for the purpose of making investigations in cooperation with the Navy and other Government Departments with coals from Appalachian regions, and also of testing coals in the form of briquettes as compared with run-of-mine coal for naval purposes. In conducting these tests at Norfolk an additional boiler of naval water-tube type and of 250 horsepower and two 300-horsepower turbo-generators have been procured and are being installed in connection with the other equipment of the section. Certain important investigations relating to combustion in locomotives have also been made under the direction of Prof. W. F. M. Goss, of Purdue University, the chief purpose of these investigations being to obtain information that will lead to the abatement of the smoke nuisance from locomotives in the city of Washington and elsewhere.

GAS-PRODUCER SECTION.

In this section are conducted investigations for the purpose of determining the practicability of utilizing in the gas producer the low-grade fuels of the country for power and light purposes and also comparative tests in respect to fuel efficiencies and values. R. H. Fernald, professor of mechanical engineering at Washington University, continued in immediate supervision of the section, with J. P. Quam as engineer of tests. This section is demonstrating that many low-grade fuels heretofore considered worthless can now be used commercially without smoke or dust.

In May and June the plant of this section was dismantled and moved to Norfolk, Va., where it is proposed to conduct investigations during the next fiscal year in conjunction with the naval authorities, and the equipment has been augmented by the addition of various smaller internal-combustion engines in which tests will be made of the relative efficiency of gasoline, kerosene, and similar fuels for use on naval vessels.

INSPECTION AND SMOKE-ABATEMENT SECTION.

This section has been in operation since October, 1906, and in it are conducted investigations in respect to the inspection, sampling, and testing of coals used by the Government at its various public buildings throughout the country, with a view to discovering methods for increased efficiency and smoke abatement; also investigations looking to the purchase of the Government coal supply upon suitable specifications. The work is under the direction of D. T. Randall. Since it was commenced 177 samples of coal from different Government buildings in Washington, D. C., and elsewhere and additional samples of coal from mines, collieries, etc., have been collected.

In conjunction with the inspection work above mentioned in Government buildings in various large cities throughout the country and as auxiliary to the work of the steam-engineering section, observations have been made in this section of various power, heating, and lighting plants in Baltimore, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Indianapolis, Louisville, New York, Philadelphia, Pittsburg, St. Louis, and Toledo, and data on the methods adopted in such cities for the abatement of smoke and the progress made therein have been obtained, as throwing light on the practicability of adopting better methods in Government power plants.

This section is also making investigations in relation to the storage of coals in large quantities, with a view to the needs of the Government.

COKING AND WASHERY SECTIONS.

The work of these sections during the last fiscal year was so intimately connected that a joint report is made on them. The coking section is under the direction of A. W. Belden, and the washery section under G. R. Delamater, with Richard Moldenke as consulting engineer. During the last fiscal year 96 cupola tests, 74 coking tests, and 27 washery tests were completed.

In June the plants of both of these sections were dismantled and removed to Denver, Colo., where they are being erected with a view to making investigations to determine the value of the coal on the public lands still belonging to the Government, the extent to which these coals may be suitable for coking and other purposes, and the extent to which they may be improved by some process of washing.

COAL WASTE AND MINE-EXPLOSIVES SECTION.

During the last fiscal year investigations of the unnecessary waste of coal in mining were undertaken by E. W. Parker, of the geologic branch. Data were obtained from numerous localities, and the work will be continued during the current fiscal year. The main purpose of these investigations is the prevention of waste in the utilization of the nation's fuel supplies.

Mr. Parker having withdrawn from the investigation on June 1, on account of pressure of other work, the administration of these investigations has been intrusted to J. Shober Burrows, in connection with his supervision of the mining and coal-sampling section.

The explosive investigations of this section are under the supervision of Clarence Hall and have for their purpose the prevention of waste and the loss of life caused by coal-mine explosions. This section is also testing the explosives for the Reclamation Service and the Isthmian Canal Commission.

BRIQUETTE SECTION.

In this section 116 investigations were conducted in making and testing briquettes from 30 varieties of coal and other fuels. The work was in immediate charge of C. T. Malcolmson.

In June the briquette plant at St. Louis was dismantled and shipped to Norfolk, Va., where it is proposed to conduct briquette investigations in respect to the coals of the Atlantic seaboard, with a view to determining the comparative efficiency of briquettes and run-of-mine coal for naval purposes and for use in locomotives. It is also proposed to make numerous investigations in connection with the briquetting of the lignites and lignitic coals found on the lands still belonging to the Government in the Western States and at other points, and for this purpose the equipment has been augmented by the purchase of a large German machine especially adapted to briquetting lignites.

MINING AND COAL-SAMPLING SECTION.

This section collects samples of coal for chemical analysis and testing from the different portions of the various coal fields which belong to the Government or from which coal supplies are needed for Government purposes. It is under the supervision of J. Shober Burrows. The inspectors in this section also make investigations relative to the extent of unnecessary waste in the mining and handling of coal.

STRUCTURAL-MATERIALS DIVISION.

The investigations of structural materials belonging to and intended for the use of the United States, such as stones, clays, cements, etc., begun in 1905 under the authority of Congress, were continued during the last fiscal year at the structural-materials testing laboratories in Forest Park, St. Louis. These investigations were continued under the general supervision of J. A. Holmes, expert in charge of the technologic branch, and were directly in charge of Richard L. Humphrey, engineer in charge of the division.

The personnel of this division remained practically the same throughout the fiscal year, embracing a corps of competent engineers, chemists, geologists, and other necessary assistants. The entire force of the division, however, with few exceptions, was organized during the fiscal year.

The work of the division embraces investigations relating to constituent materials and physical qualities of cements, gravels, sands, and other materials used in concrete and reenforced concrete and various forms of building blocks; brick, terra cotta, and other clay products; stone; and other similar materials concerning which information is desired for Government purposes. The tests of these materials determine the adhesive, compressive, and tensile strength, the coefficient of elasticity, the porosity, and the fire-resisting, weathering, and other qualities.

The following is a résumé of the operations of the division:

Summary of operations of structural-materials division.

Constituent-material test pieces (briquettes, transverse bars, cubes, and cylinders) made	11,200
The same tested	13,100
Physical tests (specific gravity, weight, etc.)	350
Beam test pieces made	2,100
The same tested	1,000
Building-block test pieces made	2,000
The same tested	1,350
Chemical analyses and determinations made	500
Fire-resisting tests conducted	25

The structural-materials laboratories are equipped with four 200,000-pound and one 100,000-pound testing machines, and sixteen smaller pieces of apparatus of different kinds adapted to the different tests, with the auxiliary appliances, instruments, and laboratory equipment necessary for conducting the investigations. A 600,000-pound vertical screw testing machine is now ready to be installed, and preparations are being made for a 1,200,000-pound vertical testing machine; these and even larger machines being rendered necessary by modern construction methods employed under the Supervising Architect, the Isthmian Canal Commission, the Reclamation Service, and other Government bureaus. The needs of the Government service also require a considerable amount of field work in determining the nature and extent of the deposits of material to be tested from different parts of the country. All of this work is arranged on such a basis of cooperation with the ordnance-testing laboratory at Watertown, Mass., as to avoid duplication.

PUBLICATION BRANCH.

EDITORIAL DIVISION.

SECTION OF TEXTS.

There were engaged in the work of this section 5 persons all of the year and 1 other person until October 31. The force was somewhat less than during the preceding year, and the amount of work done was likewise less, viz:

Manuscript pages edited, 26,912 (last year, 35,131), consisting of 1 Director's annual report, parts of 2 mineral-resources annuals, 1 monograph, 5 professional papers, 28 bulletins, 35 water-supply papers, 11 geologic folios, and miscellaneous matter.

Proof read, final pages, 16,833 (last year, 17,936), consisting of 1 Director's annual report, 1 mineral-resources annual, 2 monographs, 5 professional papers, 33 bulletins, 35 water-supply papers, 12 geologic folios, and miscellaneous matter. These publications required the handling of 7,112 galley proofs and 28,018 page proofs (handled last year, 7,861 galley proofs and 32,256 page proofs).

The indexes prepared covered 12,167 pages (last year, 15,034), for 1 Director's annual report, 1 mineral-resources annual, 2 monographs, 6 professional papers, 27 bulletins, and 30 water-supply papers.

In addition to the above-noted work on the regular series of publications, this section examined the copy and proofs of all account and record books and blanks, circulars, office cards, etc.

SECTION OF GEOLOGIC MAPS.

The progress made in folio publication was about the same as in the last few years. Although but 11 folios were completed and issued, 4 of these were of double size. The Bald Mountain-Dayton, Cloud Peak-Fort McKinney, and Lancaster-Mineral Point contain each maps of 2 adjoining quadrangles, while the Joplin Special comprises a double-sized map.

At the beginning of the year work was in progress on 7 folios, all of which have since been published, and 11 others were on file. During the year 9 folios were transmitted to the section for publication, and 11 (Nos. 140 to 150, inclusive), as listed in the following table, were completed and issued:

Geologic folios issued during the fiscal year ending June 30, 1907.

No.	Name of folio.	State.	Author.	Limiting meridians.	Limiting parallels.	Area.	Price.
						Sq. miles.	*Cents.*
140	Milwaukee Special.	Wisconsin....	Alden, W. C..	87° 50′-88° 5′....	42° 54′-43° 9′....	219	25
141	Bald Mountain-Dayton.	Wyoming	Darton, N. H.; Salisbury, R. D.	107°-108°........	44° 30′-45°	1,699	25
142	Cloud Peak-Fort McKinney.	.....do........	.....do........	106° 30′-107° 30′.	44°-44° 30′	1,713	25
143	Nantahala....	North Carolina, Tennessee	Keith, A......	83° 30′-84°	35°-35° 30′	975	25
144	Amity........	Pennsylvania	Clapp, F. G...	80°-80° 15′	40°-40° 15′	228	25
145	Lancaster-Mineral Point.	Wisconsin, Iowa, Illinois.	Grant, U. S.; Burchard, E. F.	90°-91°..........	42° 30′-43°	1,756	25
146	Rogersville...	Pennsylvania	Clapp, F. G...	80° 15′-80° 30′...	39° 45′-40°	229	25
147	Pisgah........	North Carolina, South Carolina.	Keith, A......	82° 30′-83°	35°-35° 30′	975	25
148	Joplin........	Missouri, Kansas.	Smith, W. S. T.; Siebenthal, C. E.	94° 15′-94° 45′...	37°-37° 15′	476	50
149	Penobscot Bay.	Maine........	Smith, G. O.; Bastin, E. S.; Brown, C. W.	68° 30′-69°	44°-44° 30′	857	25
150	Devils Tower.	Wyoming	Darton, N. H.; O'Harra, C. C.	104° 30′-105°	44° 30′-45°	849	25

On June 30, 1907, 11 folios were in process of engraving and 4 were on file awaiting publication. The following geologic folios were in progress of engraving June 30, 1907: Ann Arbor, Mich.; Elk Point, S. Dak.-Nebr.-Iowa; Independence, Kans.; Ouray, Colo.; Passaic, N. J.-N. Y.; Patuxent, Md.-D. C.; Roan Mountain, N. C.-Tenn.; Winslow, Ark.; Rockland, Me.; Santa Cruz, Cal.; and Watkins Glen-Catatonk, N. Y.

The following folios awaited engraving on June 30, 1907: Aberdeen-Redfield, S. Dak. (comprises 4 quadrangles); Accident-Grantsville, Md.-W. Va.-Pa. (comprises 2 quadrangles); Belle Fourche, S. Dak.; Philadelphia Special, Pa.-N. J. (comprises 4 quadrangles).

SECTION OF TOPOGRAPHIC MAPS.

A year ago the editor of topographic maps reported 68 atlas sheets in manuscript awaiting editorial examination. The accessions since that date number 88, making a total of 156. Of these, 103 have been edited and approved during the year, leaving 53 now in hand. In the editor's custody on June 30, 1907, there were 69 atlas sheets and special maps intended for publication but not yet given to the engravers; 16 of these had been edited and approved.

Against 115 topographic maps in hand for publication July 1, 1906, there were on June 30, 1907, 103—34 of them in process of engraving. Of those in hand July 1, 1906, 16 were still unpublished, though their engraving was well advanced. The number of new maps published during the year was 100.

Corrections to 152 atlas sheets and special maps were edited and prepared for engraving. The corrections to 11 of these maps were extensive, and they were reissued with new edition dates. The number reissued as reprints was 253.

The manuscript map illustrations for 37 volumes--bulletins, professional papers, water-supply papers, and an annual report—were examined and the geographic names verified or corrected. There were 362 of these maps.

The method of reproducing the index maps for the 20 mailing circulars 9–323 was changed during the year. This necessitated new copy on an enlarged scale—two plates for each of the 20 circulars. These copies were prepared in this section, and occupied the time of one man during several months.

Most of the proof readers' time was devoted to the engravers' proofs of the 100 new sheets engraved and published during the year. The engraving of the corrections to the 152 maps above noted was verified by them, and other miscellaneous proof reading was done.

SECTION OF DISTRIBUTION.

There were delivered to this section during the year 177 new documents, 109 new maps, and 255 reprints of maps, a total of 541. They were: Twenty-seventh Annual Report; Monograph L; Professional Papers Nos. 46, 50, 51, 52, 54, 55, 57; Bulletins Nos. 275, 277, 279, 282 to 287, 289 to 303, 305 to 308, 310, 312, 314, 315; Water-Supply and Irrigation Papers Nos. 155, 156, 158 to 164, 170, 172 to 194, 196, 200; Mineral Resources of the United States, 1905; Geologic Folios Nos. 136 to 149; 83 separates (50 from Mineral Resources, 1905; 12 each from Bulletins 285 and 314, and 19 from Bulletin 315), and 364 maps; the totals of all editions being 416,641 documents, 51,024 folios, and 779,021 maps; grand total, 1,246,686.

During the year 331,226 volumes, 48,944 folios, and 595,915 maps, a total of 976,085, were sent out.

The total amount received and turned into the Treasury as a result of sales of publications was $18,633.31, an increase of $998.52 over the amount received during the year 1905–6.

During the year 83,880 letters were received, answered, and filed, being 4,904 more than for the preceding year.

DIVISION OF ENGRAVING AND PRINTING.

There were on hand for publication July 1, 1906, 115 atlas sheets and other maps, of which 32 were partly engraved. During the year 88 new sheets were added, making a total of 203. The status of these 203 sheets on June 30, 1907, was as follows:

Published during the year or in press at its close (double sheets counted as one)	100
In process of engraving	34
Not taken up	69

At the close of the year, therefore, the number of atlas sheets and other maps available for publication was 103. The corresponding figures for July 1 of each of the last five years are: 1902, 166; 1903, 156; 1904, 127; 1905, 126; 1906, 115—figures which show that the arrears of engraving have been reduced at the rate of 12 sheets a year during the last five years and that the engraving is now nearly if not quite on a current-work basis.

As shown above, 100 new topographic maps were engraved. In addition to this, corrections, some of them very extensive, were made on the plates of 152 maps. Editions of 364 topographic maps were printed and delivered. Of these, 100 were the new maps noted above, 11 were old maps reissued with new edition dates, and 253 were reprints.

Eleven geologic folios were published, and upward of 45,000 copies printed and delivered. Eight of these folios were reported partly finished last year. The number in hand partly completed at the close of the year was 10.

Of miscellaneous matter of all kinds, the total number of copies printed was nearly a million and required about twice as many printings. The total number of copies printed of maps, folios, and miscellaneous matter was 1,752,508, requiring over seven million impressions. There were also 361 transfer impressions made and sent to contracting printers.

The work of the photolithographic branch very largely increased. Photolithographs were made of 48 atlas sheets as soon as the manuscripts were completed, and small preliminary office editions printed. About 2,500 other maps were photolithographed for the Reclamation Service, the topographic, water-resources, and other branches of the Survey. The photolithographic processes are much employed in the compilation of maps, and assembling the parts of maps from field sheets. For this purpose celluloid prints of 142 maps or parts of maps were made.

A new method was introduced for the photomechanical transfer of a drawing to the copperplate for the guidance of the engraver. Credit for the development of this method is due to Andrew H. Linsenmeyer, a photolithographer of the engraving division.

INSTRUMENT SHOP.

The work of the instrument shop consisted in overhauling and repairing surveying, drafting, and engraving instruments, and in making copperplates and electrotypes. More than 1,600 repairs were made to instruments, and 296 new copperplates and 32 electrotypes were finished.

SECTION OF GRAPHIC ILLUSTRATIONS.

The number and kinds of illustrations prepared were: Maps, 350; sections and diagrams, 764; paleontologic drawings, 1,925; photographs retouched, 399; landscapes, 2; miscellaneous, 192; total, 3,632.

The falling off in the total number of illustrations prepared during the year was due to a reduction in the number of illustrations of a photographic nature submitted with reports. By a reduction of such illustrations the tendency is to increase the amount of drafting, so that a larger number of drawings than formerly were prepared for direct reproduction.

Illustrations to accompany 61 publications were transmitted, viz, 32 water-supply papers, 23 bulletins, 5 professional papers, and the annual report.

At the close of the year material for illustrations of 15 reports was in hand, a part of which had already been prepared.

Proofs to the number of 2,584 were received and examined critically. On account of inferior work by contractors during the last year the amount of proof reading was increased. In the majority of cases new proofs were requested, and in many instances reengraving was ordered.

During the year 226 electrotypes were furnished to applicants not connected with the Survey, and 335 cuts from the collection filed in this office were reused in the reports.

PHOTOGRAPHIC LABORATORY.

The output of the laboratory included 11,347 negatives, of which 9,535 were glass and 1,812 were paper; 50,265 prints, of which 17,531 were map prints and 32,734 were mat prints; and 1,605 lantern slides.

The proposed change from wet plates to collodion emulsion was not made owing to pressure of work and the lack of necessary room to continue the experiments. This change will be made as soon as the results of experiments now in progress will warrant.

During the year a complete cost-keeping system was installed.

The work of mounting the 6,000 photographs for the geologic type collection was completed in December, and the typewriting of the descriptions was well advanced. When completed this collection will form a valuable addition to the Survey library, its arrangement affording instant access to photographs descriptive of different geologic phenomena. It is at present in shape for reference, but many of the titles are incomplete. These will be completed as rapidly as the necessary information can be obtained.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

CORRESPONDENCE, RECORDS, APPOINTMENTS, SUPPLIES, AND SHIPMENTS.

On account of the organization of the Reclamation Service as a separate bureau, the total amount of work performed in this section was not so great as that for the fiscal year ending June 30, 1906.

Mails, files, and records.—There were received during the year 102,400 pieces of first-class mail. Of this number 18,075 contained money remittances for sale publications of the Survey. The recording and filing of correspondence required the services throughout the year of two clerks.

Appointments, attendance, etc.—In the roster of Secretarial appointments 1,002 changes were made—more than during any previous year for the Survey alone, and nearly as many as during 1905–6, when the Reclamation Service was associated with the Survey and its large force was being rapidly built up. Of the 1,002 changes, 211 were appointments, 362 were promotions, 13 were reductions, and 116 were separations and revocations. The others included such formal and minor changes as removals of probationary limitations, extensions of temporary appointments, designations of disbursing agents, etc.

There are now on the regular rolls of the Survey 652 names.

There were recorded and granted 10,500 days of annual leave, 2,216 of sick leave, being 65 per cent of the amount of annual leave and less than 14 per cent of the amount of sick leave authorized by law; also 2,618 days of leave without pay.

Property accountability.—The system of property accounting, which in previous fiscal years employed one custodian or property clerk, was changed early in the year by the appointment, by the Secretary of the Interior, of a custodian for each branch or division. Thus this section was relieved of the preparation of property returns.

The amount of money derived from the sale at public auction of property examined by inspectors and found unserviceable was $2,946.29. During the preceding fiscal year it was $4,667.58.

Purchase and distribution of supplies.—The work of this sort performed during the year may be summarized as follows: Applications to the Secretary of the Interior for authority to purchase, 259; requisitions drawn on the Department for miscellaneous supplies, 536; orders drawn on dealers and others, 2,265. The present system concentrates in this section all operations connected with purchases in Washington.

Express, freight, and registered mail.—During the year there were handled by the shipping clerk 5,569 pieces of express and freight, of which 1,683 were outgoing and 3,886 incoming; and 16,702 pieces of registered mail were handled, of which 13,974 were forwarded and 2,728 received. During the year 555 transportation accounts were checked by the shipping clerk.

Stationery.—In the stationery room the services of two men are required for handling mails, delivering supplies throughout the office, and wrapping and shipping them to the field parties. During the year 8,394 requisitions for blanks, blank books, and miscellaneous supplies were filled, and 625 requisitions were drawn on the Department.

Administrative bookkeeper.—The most important change in this section during the year was the appointment of an administrative bookkeeper, whose duty it is to keep the accounts of the expenses of the executive division and of supplies furnished the various divisions.

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below. Only the net expenditures are shown therein, credits for services and materials furnished other Departments and Bureaus having been deducted.

FINANCIAL STATEMENT.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1907.

	Geological survey, 1907.	Geological survey, 1906-7.	Geological maps U. S., 1907.	Surveying forest reserves, 1907.	Testing fuel.	Testing structural materials.	Total.
Amount appropriated by acts of Feb. 27 and June 30, 1906	$912,020.00	$80,000.00	$100,000.00	$100,000.00	$250,000.00	$100,000.00	$1,542,020.00
Total expenditures	857,900.63	78,865.01	94,391.20	86,715.18	241,467.81	94,728.83	1,454,068.66
Balance unexpended June 30, 1907, available to meet outstanding liabilities	54,119.37	1,134.99	5,608.80	13,284.82	8,532.19	5,271.17	87,951.34

Distribution of disbursements, Geological Survey, 1907.

Salaries, Office of the Director	$34,980.35
Salaries of scientific assistants	29,462.47
Skilled laborers, etc	19,999.72
Topographic surveys	327,405.51
Geologic surveys	189,709.99
Mineral resources U. S	70,163.19
Gaging streams, etc	137,366.67
Paleontologic surveys	8,533.67
Chemical and physical researches	19,941.47
Preparation of illustrations	17,630.16
Books for the library	1,327.43
Rent of basement	1,375.00
	857,900.63

LIBRARY.

Periodicals.—About 300 periodical publications are regularly received and recorded on cards. Completed volumes are bound and then entered in the accession book.

Books accessioned.—There were entered in the accession book, in which is kept the complete record of books permanently added to the library, 2,731 books, making the total number of books entered 64,078.

Cataloguing.—During the year the work of cataloguing the publications of the various national surveys, the Canadian Geological Survey, and the various State geological surveys was completed and cards were printed by the Library of Congress. All separate works on mineralogy and petrology and text-books and general works on the geology of North and South America and of Great Britain have been catalogued. In economic geology the reports of foreign and State mining bureaus and text-books and general papers on mining and metallurgy were catalogued. Material received during the year was catalogued as received, except small and unimportant pamphlets.

Map cataloguing.—In cataloguing the publications of various geological surveys it was found necessary to catalogue a considerable number of maps. A card catalogue of maps was begun, arranged by countries and States or provinces, and it now contains approximately 1,000 cards.

Shelf listing.—Some difficulty having been experienced in finding books classified by subjects, it was determined to devote all the time possible to shelf listing the books and using the cards as temporary catalogue cards. All books on geology, paleontology, geography, mathematics, geodesy, astronomy, surveying, and engineering, not heretofore catalogued, have been shelf listed. These number 4,435.

New equipment.—Six steel pamphlet cases (four octavo and two quarto size) were installed, also one steel card cabinet case to hold the author and subject card catalogues. This completes the equipment purchased under the special appropriation of $7,000.

Foreign and domestic exchanges.—All the book publications are regularly sent to 750 institutions and individuals, and from them are received a considerable part of the additions to the library. About 450 sets of map publications are also distributed to exchanges.

Bibliographic work.—The annual bibliography and index of North American geology, paleontology, petrology, and mineralogy for 1905 was completed, combined with the bibliographies for 1901 to 1904, and published as Bulletin No. 301.

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O

UNIV. OF MICH.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

TWENTY-NINTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1908

WASHINGTON
GOVERNMENT PRINTING OFFICE
1908

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TWENTY-NINTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1907-8 comprised items amounting to $1,661,420. The plan of operations was approved by the Secretary of the Interior and a detailed statement of the work of the various branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES OF THE WORK.

LAND CLASSIFICATION.

In the last few years the Geological Survey has broadened the scope of its work in the classification of the mineral lands of the public domain. At the time of the organization of the Survey the classification intended by Congress was believed to be general in character and such as could be expressed on maps issued for the general information of the people. The present interpretation of the law is that the classification should be more definite, and therefore, during the last year, the Survey has continued its special field surveys of the coal lands belonging to the Government. The geologic, topographic, and technologic branches of the Survey and the General Land Office have cooperated in these surveys, which have provided for the classification and valuation of the coal lands and for their prompt segregation from the noncoal lands. A total of 22,700 square miles of coal fields was thus classified, and the valuation of the coal lands, based not only on the geologic field examination but on chemical and physical tests of coal collected from these lands, was reported to the General Land Office.

Increased demands have also been made on the mining geologists of the Survey for assistance in determining the mineral or nonmineral character of land for which title from the Government is sought. In all this work the sole purpose of the Geological Survey is to determine the truth of the issue from the viewpoint of an independent and impartial mining engineer, and thus to protect the interests of the people.

MINING GEOLOGY.

The development of mining geology, or the application of the science of geology to mining operations, has been to a large extent the result of the activity of the United States Geological Survey, and the practical value of the Survey's contributions in this field has won for it world-wide recognition. The actual results have demonstrated to the mining industry its dependence upon geologic investigations. This record warrants the hope for further development in mining geology.

Incidental to the surveys for the classification of coal lands important results have been secured concerning the stratigraphic and structural relations of the coal fields of the West, and the knowledge of the occurrence and distribution of this most valuable mineral has been greatly increased. Similar systematic investigations of the oil fields of the country would yield results hardly less valuable; but even the increased attention paid to this subject during the last few years, resulting this year in the publication of nine reports relating to the geology of oil, has been insufficient to keep abreast of the development in this single branch of the mineral industry.

The goal to be sought in mining geology is the extension of systematic field surveys of all mineral deposits, so that geologic exploration may keep in advance of economic development. The prosecution of detailed areal mapping in all regions where active development of mineral deposits is in progress would result in making prospecting less expensive and more efficient and in winning a much larger proportion of the ore deposits wherever the areal and structural relations thus became known, and would therefore effect a double economy.

MINING TECHNOLOGY.

In January, at the suggestion of the Senate Committee on Mines and Mining and at the request of the Secretary of the Interior, the Director of the Geological Survey submitted a statement relative to the proposed establishment of another bureau in recognition of the mining industry. The part played by the Survey in the development of that industry in the last three decades was reviewed, and the effort was made to suggest legislation that would provide adequately for an increase in the mining work of the Federal Government without duplicating work already authorized. The opinion was expressed that the only true line of cleavage for separating the investigations concerned with the mining industry lies between the pure technology of the industry and those studies which relate to the distribution, occurrence, origin, and production of mineral deposits. Such studies have formed an increasingly important part of the Geological Survey's work since its organization, so that the whole question resolves itself into the matter of making adequate provision for the other investigations now being conducted by the technologic branch of the Survey. The value of these investigations has been proved and their scope may well be expanded along technologic lines without duplicating or overlapping the work of other branches of the Survey.

On the basis of the historical development and present status of federal work in aid of the mining industry of the United States it was recommended that the function of any organization independent of the Survey should be limited to strictly technologic work, if duplication of work and rivalry are to be avoided. To that end it is important that the name of such an organization should indicate its particular function and nothing more. The word "mining" by itself is inappropriate for a bureau that would conduct only a part of those investigations which relate to mines and mining, and it was recommended that legislation establishing a new bureau should provide not for a "bureau of mining," but for a "bureau of mining technology." Such a bureau would supplement, along purely technologic lines, the geologic work of the Survey, and the two bureaus could cooperate in investigations carried on in behalf of the mining industry.

ALASKAN SURVEYS.

The progress of surveys in Alaska is shown in a table on page 41, which clearly sets forth the need for the rapid extension of both geologic and topographic mapping in the Territory. As the geologic mapping must form the basis for any fundamental study of the laws of occurrence and distribution of the mineral resources, it is evident that, with less than a fifth of the Territory mapped, no comprehensive treatment of the subject of its mineral wealth can yet be attempted. Geologic mapping necessitates the preparation of base maps, which in themselves are, indeed, among the most valuable results for the purposes of the prospector and the mine operator.

In addition to the demand for the completion of the topographic and geologic reconnaissance surveys, whose cost can be roughly estimated at $3 a square mile, there is urgent need for detailed mapping of the important mining districts. Such detailed work costs about ten times as much as the reconnaissance work and need be undertaken only in regions that give promise of becoming important producers of mineral wealth. As soon as a district is established as a producer it is economical to cover it by detailed topographic and geologic surveys at once, as the maps and reports thus become available when they are most needed by the mine operators.

The study of the water resources of Alaska, so far as they bear on the problem of placer mining, is well advanced, for, though only a comparatively small area has actually been surveyed hydrographically, the preliminary work in one of the most important placer districts is nearing completion and similar work in another has been well started.

MINERAL STATISTICS.

From the returns already received, it is known that the value of the mineral products of the United States in the calendar year 1907 exceeded a total of $2,000,000,000, and that, notwithstanding the financial depression which occurred in the latter part of the year, 1907 will be recorded as one of the most prosperous years, if not the most prosperous, in the history of the mining industry. It is interesting to note that the value of the mineral products in 1907 was approximately six times that of 1880, nearly four times that of 1887, and over three times that of 1897, only ten years before. An indication of the wonderful growth of the mineral industry, as recorded by the Survey's division of mineral resources, is afforded by the fact that the value of the coal product of 1907 was almost equal to the value of the entire mineral production of the United States ten years before. The work of keeping in touch with the new development that has caused this immense growth, and of procuring returns from the thousands of new operations, has greatly increased the work of this division of the Survey.

The endeavor to expedite the compilation and publication of the mineral statistics for 1907 has resulted in the issue of five chapters and the transmission of twelve others to the printer during the first half of the calendar year 1908, as contrasted with one issued and five others transmitted in the corresponding period last year.

The plan of cooperation between the divisions of geology and mineral resources, which is referred to in the last report, has continued with even more satisfactory results than were obtained during the two preceding years. This plan was adopted in the preparation of the volume on mineral resources for 1905, and as each geologist has become more acquainted with the statistical work and with the fact that the study of economic development is of coordinate importance with that of geologic conditions, he has entered with more enthusiasm into this work; and the chapters so far presented for publication bear effective testimony to the value of such cooperation. This method of intrusting the supervision of the statistical work to expert economic geologists was originated by Director King, and the return to the original plan is believed to have been fully warranted.

NATIONAL CONSERVATION.

The congressional enactment establishing the Geological Survey was inspired by an appreciation of the importance to the nation of its mineral resources. Since then the Survey's investigations have not only contributed largely to the development of the mining industry, especially in the public-land States, but have furnished quantitative data that are available at this time of popular awakening to the needs of national conservation.

The last year has been one of those periods through which any scientific work occasionally passes, in which the specific value and definite usefulness of results accomplished have been brought prominently into public notice. The people in general have learned to appreciate certain applications of the Survey's investigations, which heretofore have in large part appealed only to persons who had become familiar with its work by reason of their professions or special interests.

COAL RESOURCES.

The Survey's most notable contribution to the subject of national conservation during the year was the publication, on the eve of the governors' conference at the White House, of a map of the coal fields of the United States. This map presented both graphically and statistically the extent of the nation's coal reserves. Up to that time it had not been possible to prepare so accurate a map on account of lack of data regarding the shape and extent of many of the western coal fields and the quality of their coal, but during the last few years a large amount of such information has been obtained in connection with the classification and valuation of coal lands in the public-land States of the West. In carrying on this work the United States Geological Survey has mapped most of the important coal fields and has tested many of the coals, so that the information at hand was believed to be sufficiently complete and accurate to warrant its publication.

The table printed with this map shows the size, in square miles, of the coal areas represented on the map; the kind of coal; the production in 1906; the total production to January 1, 1908, including an estimate of production for 1907, to which is added 50 per cent for waste in mining; the estimated original tonnage; and the estimated amount remaining in the ground. The figures given show that the area of the more accessible coal fields of the United States is about 327,000 square miles and that they carry an estimated content available for future use of nearly 2,000 billion tons. This exhibit of the extent of the nation's supply of its most important fuel was timely in connection with the addresses of the President and other speakers at the conference.

The importance of collecting similar data for other minerals is realized, and a beginning has been made in the preparation of quantitative estimates of the nation's reserves of the other mineral fuels and the principal metals. These inventories are especially opportune at this time of unprecedented development of the mineral industry.

WATER RESOURCES.

Need of investigation.—The public interest in the importance of conserving the natural resources of the nation, aroused by the appointment of the Inland Waterways Commission, and more especially by the governors' conference, has emphasized the value of the country's water resources and the necessity for their thorough investigation.

The idea that water is our most valuable resource, as it is the most active agent in changing or modifying or limiting all those other resources which are so necessary to commercial and economic development, is by no means new. Prominent engineers in this country have long recognized it and have advocated the extension of the government investigations of water resources; and in European countries centuries of experience have demonstrated that water investigations are necessary to a continuance of prosperity. If the United States were to provide for the prosecution of this work on a scale of thoroughness equal to that of the Republic of Switzerland, for example, it would appropriate $11,000,000 annually, a sum 110 times greater than the present annual appropriation for similar work in this country.

Legislative provision for the investigation of water resources is one of the most important of those necessary acts that may be called anticipatory. The immediate value or application of the results of such investigations is outweighed by their prospective value—a value which will become greater as the passage of years brings increased population and consequent enlarged demands on these resources.

Obviously, if water resources are to be utilized, the first step must be to determine their extent and character. A brief statement of a few of the industrial and social problems of the present day in which the utilization of water is the controlling factor is given in the following paragraphs.

Floods.—The average annual damage by floods in the United States has never been accurately determined, but such investigations as have been made indicate that the loss must be at least $100,000,000 annually. It appears that, in many parts of the United States, the proper expenditure of an amount equal to one year's flood loss would prevent future floods; in other parts of the country the cost would probably equal the flood losses of two or more years, but in every locality prevention could be accomplished by an expenditure equivalent to the losses from the floods of a few years.

In few flood regions, however, could this result be accomplished except under federal action. Most of the rivers are interstate. Their basins were defined many thousands of years before state boundaries were conceived. The proper treatment of the flood question must therefore follow the limits imposed by nature rather than the artificial lines defining the sovereignty of the various States. Prevention of floods is purely an engineering problem, and the engineers who have thoroughly investigated it realize the necessity for federal regulation.

On another feature of this subject the engineering profession is also agreed; namely, that whatever means may be finally adopted to prevent this great devastation, the results of investigations of rivers must be available to show their habits, flows, seasonal changes, and eccentricities; and, moreover, such investigations must extend over a period of years and be practically completed before remedial measures can be applied.

Inland navigation.—Several hundred million dollars have been expended by the Government for river improvement, and it is probable that as much, if not more, must be expended during the next decade. No one will contend that all past expenditures have been wise, as each year brings new knowledge which changes ideas and renders old practice inadvisable. To quote from the address of the President before the conference of governors at the White House on May 13, 1908:

> Our natural waterways are not gone, but they have been so injured by neglect, by the division of responsibility and utter lack of system in dealing with them, that there is less navigation on them now than there was fifty years ago.

Whatever may be the process by which inland navigation shall be rehabilitated, whatever may be the system under which the United States shall make its improvements, all engineers agree that thorough investigation of rivers is absolutely necessary to the final solution of the problem.

Irrigation.—The United States is spending $40,000,000 in the construction of irrigation systems. The great factor that will determine the success or failure of this investment is the water supply. It is necessary to deliver to irrigated areas certain amounts of water, and an irrigation project constructed in any region in which there is not sufficient water must fail. A trip through the arid West will disclose thousands of acres in which irrigation systems constructed by private enterprise have failed for lack of proper investigation before construction.

Whether or not there is water sufficient for any irrigation project can not be determined by mere inspection or by measurements covering a short period of time. When the reclamation act was passed, in 1902, it was possible for the Government to proceed at once with certain projects because the Geological Survey had on file the results of stream measurements showing that sufficient water was available for these projects. Various reclamation projects based on such exact information have been constructed or are under way, and money is being returned to the Treasury under the terms of the reclamation act. This returned money will be available for the construction of other projects, and information concerning the amount of water available for these will be as necessary as it was for the earlier work. The Reclamation Service has no legal power to make general investigations of stream flow, and obviously it would be unjust to charge the cost of general investigations over all the arid West against specific projects. In other words, the continued investigation of the water resources of the arid country will safeguard $40,000,000 of government expenditure.

Drainage of wet lands.—More than 80,000,000 acres of the best agricultural lands in the United States are unproductive because they need drainage. The lands are so widespread that their drainage is being agitated as a national issue, for many believe that these wet lands should be reclaimed under federal authority, as are the arid lands of the West. To the success of this work the investigation of water resources, as well as accurate topographic mapping, is as necessary as it is to the success of irrigation enterprises.

If the sentiment in the United States shall finally become so strong that the Government will be obliged to undertake the work of wet-land reclamation, the basic data should be in hand in order that the work may be promptly and properly performed.

Water power.—More than half of the present coal consumption in the United States is used for the generation of power. The substitution of water power for this fuel power would result not only in saving the coal but in great financial saving to the people of the whole country, because water power is already cheaper than that derived from fuel. With impoverishment of the coal resources water power will become increasingly important and the investigation of these power resources will be more urgently demanded.

The United States Government is at the present time the largest owner of potential water powers, and investigation of these powers available in the public lands is a matter of public duty. In the absence of specific information concerning its value, a water power may be easily acquired, and water-power rights have thus gone from the control of the Government for a fraction of their real value, not for useful development, but for speculative holding, which involves keeping them for long periods in a nonproductive state. Enormous water powers outside of the public domain are being procured at extremely low valuations, and although the development of these powers will undoubtedly be of ultimate benefit to the people at large, their extent and value should be matters of public record.

TECHNOLOGIC INVESTIGATIONS.

The technologic investigations conducted by the Geological Survey during the last year have been planned to contribute to the conservation of the nation's mineral resources. In the investigations relating to the mineral fuels attention has been given not only to the waste in mining but more especially to the much greater loss in utilization. The promotion of increased efficiency has been sought by steam-engineering investigations, gas-producer and briquetting tests, and smoke-abatement experiments. The extent of mine waste has been studied and plans have been perfected for commencing an adequate investigation of mine explosions and for conducting tests of explosives—a line of practical research that is expected to decrease in some degree the present excessive loss of life in the mines as well as to diminish the waste of coal in mining.

The structural-materials investigations have included inquiries into the nature, extent, and distribution of materials needed for use by the Government in its building and construction work (the cost of which now aggregates about $40,000,000 annually), in order to meet the urgent needs for accurate data concerning the strength and the fire-resisting and other properties of concrete, clay products, stone, and other building materials, with the view not only to make construction secure but to lessen waste due to use of materials in excessive amounts and with poor protection against fire.

MAP PUBLICATION.

The increasing popularity among private citizens of the topographic maps issued by the Survey is being paralleled by the growing appreciation of the maps by the government departments. Of the 40,000 maps distributed to the departments last year for official use, more than 5,000 were delivered to the Forest Service and 3,600 to the War Department. The increased use of the maps by the Forest Service, the War College, and the service schools is especially noteworthy. They are used in administering the national forests, in planning military operations, and as bases for military maps, and the text-books in use at West Point recognize them as the mother maps to which the army officers can add detailed data of purely military value.

The efficiency of the engraving and printing force of the Survey is appreciated by other branches of the government service, and during the last year there has been a notable increase in the amount of map printing done by the Survey, not only for the other bureaus of the

Interior Department, but especially for the Forest Service and the Public Printer. Large contracts have been awarded to the Survey on bids made in competition with outside contractors. Contracts of this character performed during the year for other bureaus and offices aggregated 30 per cent of the work of the engraving division.

ORGANIZATION.

Another line of investigation was placed under the administration of the Geological Survey in May by authority of the Secretary of the Interior, upon the appropriation by Congress of $150,000 for conducting investigations of the causes of mine explosions, with a view to increasing safety in mining. The division of mine accidents was created May 22, 1908, and made a part of the technologic branch. The organization of this new work was immediately begun and authority was obtained from the Secretary of War for the use of a part of the old arsenal tract in Pittsburg as an explosive station. Before the end of the fiscal year plans had been perfected, contracts awarded, and progress made in equipping for this use certain of the government buildings at Pittsburg. It is proposed to concentrate, for the present, the other work of the technologic branch at this testing station.

In August, 1907, David T. Day, who for more than twenty years had been in charge of the division of mineral resources, was, at his own request, relieved of administrative charge of the division in order that he might take up special studies of the character of American petroleums and the statistics of petroleum production. Edward W. Parker was promoted to become the administrative chief of the division, with the title "statistician in charge."

The reorganization of the topographic branch, begun in March, 1907, was completed January 18, 1908, by the promotion of Robert B. Marshall, geographer, to the position of chief geographer.

Other changes in the personnel were the promotion of George M. Wood, assistant editor, to the vacancy caused by the resignation of P. C. Warman as editor, Mr. Warman continuing in the book publication division, and the designation of Miss Julia L. V. McCord as acting librarian on the resignation of Fred B. Weeks, who had been librarian since 1902.

The establishment of local offices in the West for at least a portion of the year has proved to be of advantage, not only in insuring better administration of the field work and in facilitating the discharge of official business, but in encouraging closer relations between the Survey and the public. This has been especially advantageous in the work of the water-resources and topographic branches, as it is important to provide for the engineers in any district every possible opportunity to be informed of and to profit by the investigations of the Survey and to assist the Survey in meeting local needs.

WORK OF THE YEAR.

PUBLICATIONS.

The Survey is a bureau of investigation and publication. Its relation to the public requires that the results of the scientific investigations intrusted to it be presented in the form best adapted to serve the purpose of publicity and that these reports of investigations be distributed with the greatest possible care and expedition. The current publications therefore furnish an important index to the nature and value of the work of the Survey. Summaries of the book publications issued during the last fiscal year follow:

Twenty-Eighth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1907. iv, 80 pp., 1 pl.

A summary account of the work of the year, by branches and divisions, with a map showing area covered by topographic surveys.

Monograph XLIX. The Ceratopsia, by John B. Hatcher; based on preliminary studies by Othniel C. Marsh; edited and completed by Richard S. Lull. xxx, 300 pp., 51 pls., 125 text figures.

Descriptions of the remains of an order of Cretaceous Reptilia found in Montana, Wyoming, and Colorado, with foreword and sketch of the life and work of Mr. Hatcher by Henry Fairfield Osborn, and prefaces by the author and the editor. Part I, by J. B. Hatcher, comprises the history of discovery of the remains, the classification, the osteology, and the systematic description; Part II, by R. S. Lull, is devoted to the phylogeny, taxonomy, distribution, habits, and environment of the Ceratopsia.

Professional Paper 53. Geology and water resources of the Bighorn Basin, Wyoming, by Cassius A. Fisher. vi, 72 pp., 16 pls., 1 text figure.

A description of the topography and stratigraphy of the region, with brief accounts of the structure and geologic history and sections on the water resources and mineral resources, geologic map and sections, diagram representing the structure of the basin, map showing irrigated and irrigable lands, and half-tone plates illustrating the geologic features of the country.

Professional Paper 56. Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil, by A. C. Veatch. vi, 178 pp., 26 pls., 9 text figures.

A historical review of exploration in the region (with bibliography); descriptions of the geography, stratigraphy, and structure; and an account of the economic resources, principally coal and oil. Three large pocket maps and a sheet of cross sections show the geology and the land subdivisions, and a large map with the text indicates irrigated and irrigable lands.

Bulletin 304. Oil and gas fields of Greene County, Pa., by Ralph W. Stone and Frederick G. Clapp. 110 pp., 3 pls., 7 text figures.

An account of the geology of southwestern Pennsylvania, with descriptions of the oil and gas sands and fields, brief judgments as to the limits of the productive territory, and table of well records. The large pocket map (scale 1 mile to the inch) shows the location of oil and gas wells and of dry wells and the outcrops of important coals.

Bulletin 309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by George H. Eldridge and Ralph Arnold. xi, 266 pp., 41 pls., 17 text figures.

Descriptions by Mr. Eldridge of the geologic features of the districts and detailed descriptions of the oil fields, with accounts of the oil wells and a bibliography of southern California oils, followed by a report on the physical and chemical properties of southern California oils and descriptions of the fossils of the oil-bearing formations, by Mr. Arnold. The illustrations include geologic maps of the oil fields, geologic sections, and views of fossils.

Bulletin 311. The green schists and associated granites and porphyries of Rhode Island, by Benjamin K. Emerson and Joseph H. Perry. 74 pp., 2 pls., 6 text figures.

A petrographic description of the stratified and igneous rocks, in order of geologic age, with map of the crystalline rocks in the vicinity of Providence and Narragansett Bay.

Bulletin 313. The granites of Maine, by T. Nelson Dale, with an introduction by George Otis Smith; prepared in cooperation with the Maine State Survey Commission. 202 pp., 14 pls., 39 text figures.

The introduction describes the distribution and geologic relations of the granite and states the scope of the report. Part I consists of a scientific discussion of granites proper and of the so-called black granites. Part II includes economic and technologic descriptions of Maine granites and quarries, statistics, bibliography, and glossary. A pocket map shows the distribution of granite in Maine, and illustrations show features of structure at various quarries.

Bulletin 316. Contributions to economic geology, 1906: Part II, Coal, lignite, and peat; Marius R. Campbell, geologist in charge. 543 pp., 23 pls., 6 text figures.

An introduction by M. R. Campbell summarizes the work done in the coal fields of the United States during the year and contains a brief note on technologic and laboratory work on coals. The remainder of the bulletin consists of the following papers:

Coals of the Clarion quadrangle, Clarion County, Pa., by E. F. Lines.

Coal resources of Johnstown (Pa.) and vicinity, by W. C. Phalen.

The Elkhorn (Ky.) coal field, by R. W. Stone.

The Russell Fork (Va.) coal field, by R. W. Stone.

Coal mining at Dante, Va., by R. W. Stone.

The northern part of the Cahaba (Ala.) coal field, by Charles Butts.

Coal investigation in the Saline-Gallatin (Ill.) field and the adjoining area, by F. W. De Wolf.

The Arkansas coal field, by A. J. Collier.

The Great Falls (Mont.) coal field, by C. A. Fisher.

Coals of Carbon County, Mont., by N. H. Darton.

The coal fields of parts of Dawson, Rosebud, and Custer counties, Mont., by A. G. Leonard.

Coal fields in a portion of central Uinta County, Wyo., by A. R. Schultz.

The Lander (Wyo.) coal field, by E. G. Woodruff.

Coal fields of east-central Carbon County, Wyo., by A. C. Veatch.

Coal of Laramie Basin (Wyo.), by C. E. Siebenthal.

Coal fields of the Danforth Hills and Grand Hogback, in northwestern Colorado, by H. S. Gale.

The Book Cliffs coal field between Grand River, Colorado, and Sunnyside, Utah, by G. B. Richardson.

The Durango (Colo.) coal district, by J. A. Taff.

The Pleasant Valley coal district, Carbon and Emery counties, Utah, by J. A Taff.

The Iron County (Utah) coal field, by W. T. Lee.

A reconnaissance survey of the western part of the Durango-Gallup coal field of Colorado and New Mexico, by M. K. Shaler.

The Una del Gato coal field, Sandoval County, N. Mex., by M. R. Campbell.

Coal in the vicinity of Fort Stanton Reservation, Lincoln County, N. Mex., by M. R. Campbell.

Coal of Stone Canyon, Monterey County, Cal., by M. R. Campbell.

The present status of the producer-gas power plant in the United States, by R. H. Fernald.

Condition of the coal-briquetting industry of the United States, by E. W. Parker.

The importance of uniform and systematic coal-mine sampling, by J. S. Burrows.

List of Survey papers on coal, lignite, and peat, by W. T. Lee and J. M. Nickles.

Bulletin 317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 69 pp., 2 pls., 1 text figure.

A brief abstract of the report issued later as Bulletin 322, issued to meet urgent demand for early publication of available facts.

Bulletin 318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, West Virginia, and Pennsylvania, by W. T. Griswold and M. J. Munn. 196 pp., 13 pls.

Part I includes a theoretical discussion of the occurrence of petroleum and natural gas, a statement of the method of investigation, and descriptions of the general geology. Part II consists of detailed descriptions of the stratigraphy, with well logs or sections. Maps show the location of oil and gas wells and the depth of the oil sands from the surface.

Bulletin 319. Summary of the controlling factors of artesian flows, by Myron L. Fuller. 44 pp., 7 pls., 17 text figures.

A sketch of ground-water conditions, including descriptions of reservoirs and sources of water, and discussions of the nature of artesian circulation and the requisites of artesian flows, with plates and diagrams showing artesian reservoirs and conditions of flow.

Bulletin 320. The Downtown district of Leadville, Colo., by Samuel F. Emmons and John D. Irving. 75 pp., 7 pls., 5 text figures.

A brief description of the general geology, a statement of the economic development and present conditions, a sketch of the faults and the porphyry sheets, and an account of the ores with a discussion of their genesis. The illustrations consist of a geologic map of the district, with cross sections, and text figures showing mine plans, sections, and workings.

Bulletin 321. Geology and oil resources of the Summerland district, Santa Barbara County, Cal., by Ralph Arnold. 93 pp., 17 pls., 3 text figures.

A record of previous publications on the region, a sketch of the topography, descriptions and tentative correlation of the geologic formations, and notes on the wells, with logs or sections, conclusions as to future development, a statement of the physical and chemical properties and composition of the oil, and a section on technology and production. The illustrations comprise geologic and structural maps, geologic sections, and half-tone reproductions of photographs, including views of fossils of the various formations.

Bulletin 322. Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Cal., by Ralph Arnold and Robert Anderson. 161 pp., 26 pls.

An account of the previous knowledge of the geology of the region, a sketch of the geography and topography, descriptions of the rocks, the geologic history, and the structure and conditions affecting the presence of oil, with detailed notes on the developed territory and a section on the oil, including accounts of its origin, physical and chemical properties, and the associated hydrocarbons, and a brief report on the technology of production and utilization. The illustrations consist of maps and half-tone views.

Bulletin 323. Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to July 31, 1906, by N. W. Lord. 49 pp.

A report on investigations of the chemical and physical properties of coal, including results of tests for moisture, showing changes in moisture content under various conditions, determinations of specific gravity, impurities in coal as related to specific gravity and fineness, adaptability of different coals to improvement by washing, and content of volatile matter in coals and lignites.

Bulletin 324. The San Francisco earthquake and fire of April 18, 1906, and their effects on structures and structural materials. Reports by Grove K. Gilbert, Richard L. Humphrey, John S. Sewell, and Frank Soulé, with preface by Joseph A. Holmes. xii, 170 pp., 57 pls., 2 text figures.

The preface states the origin and nature of the investigation. Mr. Gilbert's report considers the earthquake as a natural phenomenon, with respect to its origin and effect on the earth's crust. Mr. Humphrey's, Mr. Sewell's, and Mr. Soulé's reports discuss the effect of the earthquake and fire on structures and structural materials. The illustrations include maps showing the course of the fault or line of earth slippage and the location and extent of the burned district, and half-tone reproductions of photographs exhibiting the nature and extent of the effects of the earthquake and fire on various structures.

Bulletin 325. A study of 400 steaming tests made at the fuel-testing plant, St. Louis, Mo., in 1904, 1905, and 1906, by Lester P. Breckenridge. 196 pp., 76 text figures.

A report on a series of tests made under two water-tube boilers with a hand-fired furnace to determine the relative value of various coals for steaming purposes. The results of the tests are expressed by numerous diagrams, tables, and mathematical equations. The general conclusions and commercial considerations are stated in a few pages at the end of the report, and are followed by a bibliography and a glossary.

Bulletin 326. The Arkansas coal field, by Arthur J. Collier; with reports on the paleontology by David White and G. H. Girty. vi, 158 pp., 6 pls., 29 text figures.

A brief account of the geography and stratigraphy of the field, reports on fossil plants and marine invertebrate fossils, descriptions of geologic structure, coal beds, and conditions of mining development, with classification and analyses of the coals, a section on methods of mining, a table of mines, openings, and exposures, and geologic and economic maps and sections.

Bulletin 327. Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska, by Sidney Paige and Adolph Knopf. 71 pp., 4 pls., 4 text figures.

A sketch of the geography and geology of the region and a description of the deposits of coal, gold, and copper, with topographic and geologic maps and sections and half-tone views.

Bulletin 328. The gold placers of parts of Seward Peninsula, Alaska, including the Nome, Council, Kougarok, Port Clarence, and Goodhope precincts, by Arthur J. Collier, Frank L. Hess, Philip S. Smith, and Alfred H. Brooks. 343 pp., 11 pls., 19 text figures.

A preface, by A. H. Brooks, is followed by reports with titles and authorship as indicated below.

Development of the mining industry, by A. H. Brooks.
Geography and geology, by A. J. Collier.
Outline of economic geology, by A. H. Brooks.
Description of placers, by A. J. Collier and F. L. Hess.
The Bluff region, by A. H. Brooks.
The Kougarok region, by A. H. Brooks.
Geology and mineral resources of Iron Creek, by P. S. Smith.

The illustrations include sketch maps and sections and large pocket maps showing topography, geology, and location of placers.

Bulletin 329. Organization, equipment, and operation of the structural-materials testing laboratories at St. Louis, Mo., by Richard L. Humphrey; with preface by Joseph A. Holmes. xi, 84 pp., 25 pls., 9 text figures.

A brief history of the establishment of the laboratories, with statement of personnel, description of the buildings and equipment, and sketch of work done and projected, illustrated by views and diagrams showing apparatus employed and results of tests.

Bulletin 330. The data of geochemistry, by Frank W. Clarke. 716 pp.

A manual of geologic chemistry, including chapters on the nature, distribution, and relative abundance of the chemical elements, the composition of the atmosphere and of volcanic gases and sublimates, the mineral content of surface and underground waters, the nature of saline residues, the molten magma of the earth's interior, the rock-forming minerals, the composition of igneous, sedimentary, and metamorphic rocks, rock metamorphism and decomposition, metallic ores, natural hydrocarbons, coal, lignite, and peat.

Bulletin 331. Portland cement mortars and their constituent materials; results of tests made at the structural-materials testing laboratories, Forest Park, St. Louis, Mo., 1905–1907, by Richard L. Humphrey and William Jordan, jr. vii, 130 pp., 20 pls., 22 text figures.

Records, tables, diagrams, and views showing nature and results of 25,000 tests of cements, sands, gravels, crushed stone, and other materials.

Bulletin 332. Report of the United States fuel-testing plant at St. Louis, Mo., January 1, 1906, to June 30, 1907. Joseph A. Holmes, in charge. 299 pp.

An introduction, by J. A. Holmes, states briefly the work done and projected. The body of the report consists of the following papers:

Field work, by E. W. Parker and J. S. Burrows.
Work of the chemical laboratory, by N. W. Lord.
Steaming tests, by L. P. Breckenridge.
Producer-gas tests, by R. H. Fernald.

Washing tests, by G. R. Delamater.
Coking tests, by A. W. Belden.
Cupola tests on coke, by Richard Moldenke.
Briquetting tests, by C. T. Malcolmson.
Results of tests by States.

Bulletin 333. Coal-mine accidents: Their causes and prevention. A preliminary statistical report, by Clarence Hall and Walter O. Snelling, with introduction by Joseph A. Holmes. 21 pp.

Tables showing the number of men killed by accidents in coal mines in the United States during many years, the number of men killed in various other countries for each thousand employed, and the number killed for each million tons of coal mined, with statement of causes of accidents and suggestions as to their prevention.

Bulletin 334. The burning of coal without smoke in boiler plants. A preliminary report, by D. T. Randall. 26 pp.

A sketch of prevailing conditions in the United States as to smoke from furnaces, and of city ordinances for its prevention, and a statement of the causes of smoke and of methods for preventing it, with a bibliography.

Bulletin 335. Geology and mineral resources of the Controller Bay region, Alaska, by G. C. Martin. 141 pp., 10 pls., 2 text figures.

An account of surveys made in the region, of the commercial developments, the general character of the country, climate, vegetation, settlements, harbors, and railway routes; a description of the land forms, the geology, and the coal and petroleum deposits, with results of analyses and tests and prospects of development. The illustrations include maps showing topography, geology, and location of coal beds and oil wells and seepages.

Bulletin 336. Washing and coking tests of coal and cupola tests of coke, conducted by the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to June 30, 1907, by Richard Moldenke, A. W. Belden, and G. R. Delamater, with introduction by J. A. Holmes. 76 pp.

Tables showing the results of 65 washing tests, 192 coking tests of 102 coals, and 172 cupola tests, with statement of equipment and methods of operation.

Bulletin 337. The Fairbanks and Rampart quadrangles, Yukon-Tanana region, Alaska, by L. M. Prindle; with a section on the Rampart placers by F. L. Hess, and a paper on the water supply of the Fairbanks region by C. C. Covert. 102 pp., 5 pls., 3 text figures.

A sketch of the geography, climate, and vegetation, descriptions of the rocks and the economic geology, an account of the hydrography of part of the region and of the placer diggings near Rampart, with maps showing the topography, geology, and timber.

Bulletin 339. The purchase of coal under government and commercial specifications on the basis of its heating value, with analyses of coal delivered under government contracts, by D. T. Randall. 27 pp.

A statement of the advantages of definite specifications in the purchase of coal, of the requirements for proper combustion, and of the valuable constituents of coals, with reprint of specifications used by the United States Government in coal purchases, notes on methods of sampling and testing, analyses of coals delivered to the Government, and a brief bibliography.

Bulletin 342. Results of spirit leveling in California, 1896 to 1907, inclusive, by S. S. Gannett and D. H. Baldwin. 172 pp.

Descriptions and elevations of bench marks in 42 counties, furnishing vertical control for one-third of the State, the engineering data being grouped under the headings "precise leveling" and "primary leveling," according to the degree of refinement in the methods employed. A compilation of the results of field work by several topographers.

Bulletin 343. Binders for coal briquets: Investigations made at the fuel-testing plant, St. Louis, Mo., by James E. Mills. 56 pp., 1 text figure.

A discussion of the characteristics of good briquets and of the conditions governing the use of binders, and an account of laboratory investigations of various binders, of experiments in briquetting without binders, and of results of tests in briquetting coals, with a brief bibliography.

Bulletin 344. The strength of concrete beams: Results of tests of 108 beams (first series) made at the structural-materials testing laboratories, by Richard L. Humphrey. 59 pp., 1 pl., 13 text figures.

A note on the scope of the investigation and a summary of its results, followed by statements of tests of constituent materials, methods of preparing test pieces and of testing, and diagrams and tables showing in detail the results of the tests.

Water-Supply Paper 195. Underground waters of Missouri; their geology and utilization, by Edward M. Shepard. x, 224 pp., 6 pls., 6 text figures.

A statement of the requisite conditions for flowing wells, descriptions of the topography and geology, a brief sketch of the geologic history, a detailed report of the underground waters, by districts and counties, a section on city water supplies, with statistical tables and analyses, and notes on mineral and blowing well. The illustrations include a geologic and artesian well map and geologic cross sections.

Water-Supply Paper 197. Water resources of Georgia, by B. M. Hall and M. R. Hall. 342 pp., 1 pl.

Sketches of the topography and geology and of the uses of water in the State, descriptions of the river basins, tables showing gage heights and flow of the streams, tabulated results of river surveys giving elevations of the water surface of streams at certain points, and detailed notes on water powers.

Water-Supply Paper 198. Water resources of the Kennebec River basin, Maine, by H. K. Barrows; with a section on the quality of Kennebec River water, by George C. Whipple. vi, 235 pp., 7 pls., 17 text figures.

Brief descriptions of the geology, drainage, forest conditions, population, industries, and transportation facilities, sections on precipitation, snow storage and evaporation, detailed accounts of stream flow, floods, water powers and water storage, and the results of examinations of the quality of the water, a section on the typhoid fever epidemic of 1902–3, and a gazetteer of the rivers, lakes, and ponds in the basin.

Water-Supply Paper 199. Underground water in Sanpete and central Sevier valleys, Utah, by G. B. Richardson. 63 pp., 6 pls., 5 text figures.

A sketch of the topography and geology of the region and of the sources, distribution, and quality of the underground water, a statement of methods adopted and suggestions offered for its recovery, and detailed descriptions, by localities, of wells and water resources, with tables giving data concerning wells and springs.

Water-Supply Paper 201. Surface water supply of New England, 1906 (Atlantic coast of New England drainage); H. K. Barrows, district hydrographer. 120 pp., 5 pls., 2 text figures.

Water-Supply Paper 202. Surface water supply of Hudson, Passaic, Raritan, and Delaware river drainages, 1906; H. K. Barrows and N. C. Grover, district hydrographers. iv, 77 pp., 2 pls., 2 text figures.

Water-Supply Paper 203. Surface water supply of Middle Atlantic States, 1906 (Susquehanna, Gunpowder, Patapsco, Potomac, James, Roanoke, and Yadkin river drainages); N. C. Grover, district hydrographer. iv, 100 pp., 4 pls., 2 text figures.

Water-Supply Paper 204. Surface water supply of Southern Atlantic and Eastern Gulf States, 1906 (Santee, Savannah, Ogeechee, and Altamaha rivers and eastern Gulf of Mexico drainages); M. R. Hall, district hydrographer. v, 110 pp., 5 pls., 2 text figures.

Water-Supply Paper 205. Surface water supply of Ohio and lower eastern Mississippi river drainages, 1906; M. R. Hall, N. C. Grover, and A. H. Horton, district hydrographers. 123 pp., 3 pls., 2 text figures.

Water-Supply Paper 206. Surface water supply of Great Lakes and St. Lawrence River drainages, 1906; H. K. Barrows, A. H. Horton, district hydrographers. vi, 98 pp., 3 pls., 2 text figures.

Water-Supply Paper 207. Surface water supply of upper Mississippi River and Hudson Bay drainages, 1906; A. H. Horton and Robert Follansbee, district hydrographers. v, 94 pp., 4 pls., 2 text figures.

Water-Supply Paper 208. Surface water supply of Missouri River drainage, 1906; Robert Follansbee, R. I. Meeker, and J. E. Stewart, district hydrographers. vi, 190 pp., 5 pls., 2 text figures.

Water-Supply Paper 209. Surface water supply of lower western Mississippi River drainage, 1906; R. I. Meeker and J. M. Giles, district hydrographers. iv, 79 pp., 2 pls., 2 text figures.

Water-Supply Paper 210. Surface water supply of western Gulf of Mexico and Rio Grande drainages, 1906; T. U. Taylor and W. A. Lamb, district hydrographers. 114 pp., 2 pls., 2 text figures.

Water-Supply Paper 211. Surface water supply of Colorado River drainage above Yuma, 1906; R. I. Meeker, H. S. Reed, district hydrographers. 149 pp., 2 pls., 2 text figures.

Water-Supply Paper 212. Surface water supply of the Great Basin drainage, 1906; E. C. La Rue, Thomas Grieve, jr., and Henry Thurtell, district hydrographers. iv, 98 pp., 2 pls., 2 text figures.

Water-Supply Paper 213. Surface water supply of California, 1906; with a section on ground-water levels in southern California (Great Basin and Pacific Ocean drainages in California and lower Colorado River drainage); W. B. Clapp, district hydrographer. In cooperation with California state board of examiners. 219 pp., 4 pls., 2 text figures.

Water-Supply Paper 214. Surface water supply of the north Pacific coast drainage, 1906; J. C. Stevens, Robert Follansbee, and E. C. La Rue, district hydrographers. Work in Oregon done in cooperation with the state engineer. vi, 208 pp., 3 pls., 2 text figures.

Fourteen papers comprising the results of stream measurements in the United States during the calendar year 1906, continuing the series published in previous years under the title "Report of progress of stream measurements." These papers give gage-height records, results of current-meter measurements, rating tables, and estimates of monthly discharge for stations maintained on streams in many of the important drainage basins of the country.

Water-Supply Paper 215. Geology and water resources of a portion of the Missouri River valley in northeastern Nebraska, by G. E. Condra. 59 pp., 11 pls.

Descriptions of the stratigraphy, structure, and rocks, and of the mineral and water resources, with geologic map and sections and map showing underground water conditions.

Water-Supply Paper 216. Geology and water resources of the Republican River valley and adjacent areas, Nebraska, by G. E. Condra. 71 pp., 13 pls., 3 text figures.

Notes on the topography, drainage, and climate, descriptions of the geology and mineral resources, and detailed accounts of the surface and underground waters, of the water supply by counties, and of the water power and agricultural resources, with geologic maps and sections and half-tone illustrations.

Water-Supply Paper 217. Water resources of Beaver Valley, Utah, by Willis T. Lee. 57 pp., 1 pl., 3 text figures.

Sketch of the geography and geology, records of rainfall and stream measurements, and an account of the springs and wells, with well sections and statistics of wells and springs, including assays and chemical determinations of content of waters and notes on possibilities of development.

Water-Supply Paper 218. Water-supply investigations in Alaska, 1906–1907, Nome and Kougarok regions, Seward Peninsula; Fairbanks district, Yukon-Tanana region, by Fred F. Henshaw and C. C. Covert. 156 pp., 12 pls., 2 text figures.

Descriptions of the areas and of the conditions affecting water supply, lists of gaging stations, tables showing stream flow, and meteorological records, with maps indicating the location of gaging and rainfall stations.

Mineral Resources of the United States, calendar year 1906. 1,307 pp., 2 text figures.

Statistics of production of mineral substances in the United States, including an account of the chief features of mining progress, and comparisons of past and present conditions. This report is a consolidation of 45 separate chapters, each treating of a separate mining industry, published in pamphlet form in advance of the publication of the volume.

Advance chapters from "Mineral Resources of the United States, calendar year 1907," as follows: The production of bauxite and aluminum, by W. C. Phalen. 15 pp. The cement industry in the United States in 1907, by Edwin C. Eckel. 19 pp. The production of monazite and zircon in 1907, by Douglas B. Sterrett. 12 pp. The production of phosphate rock in 1907, by F. B. Van Horn. 9 pp. The production of asbestos in 1907, by J. S. Diller. 14 pp.

Statistics of production of the minerals, chief features of mining progress, and comparisons of past and present conditions, as in previously published reports.

Geologic folio 151. Description of the Roan Mountain quadrangle, comprising 963 square miles in Washington, Sullivan, Carter, and Unicoi counties, Tenn., and Yancey and Mitchell counties, N. C.; by Arthur Keith. 11 folio pages of text, 4 maps showing topography, geology, and mineral resources, a sheet of columnar and structure sections, and 2 pages of reproductions of photographs illustrating physiography and geology.

Geologic folio 152. Description of the Patuxent quadrangle, comprising 931.5 square miles, of which 24 square miles are in the District of Columbia and the remainder in Maryland. Prepared under the supervision of William Bullock Clark, state geologist of Maryland, by George B. Shattuck, Benjamin L. Miller, and Arthur Bibbins. 12 folio pages of text, 3 maps, and 1 columnar section.

Geologic folio 153. Description of the Ouray quadrangle, an area 234.87 square miles in extent in southwestern Colorado, with the mining town of Ouray in the southwest part of the quadrangle; geography and general geology by Whitman Cross and Ernest Howe; economic geology by J. D. Irving and Whitman Cross. 20 folio pages of text, 3 maps, 1 columnar section sheet, and 1 sheet of illustrations exhibiting physiographic features.

Geologic folio 154. Description of the Winslow quadrangle, comprising 940 square miles of the Ozark region of western Arkansas and about 29 square miles of Oklahoma; by A. H. Purdue. 6 folio pages of text, 2 maps showing topography and areal geology, and 1 sheet of columnar sections.

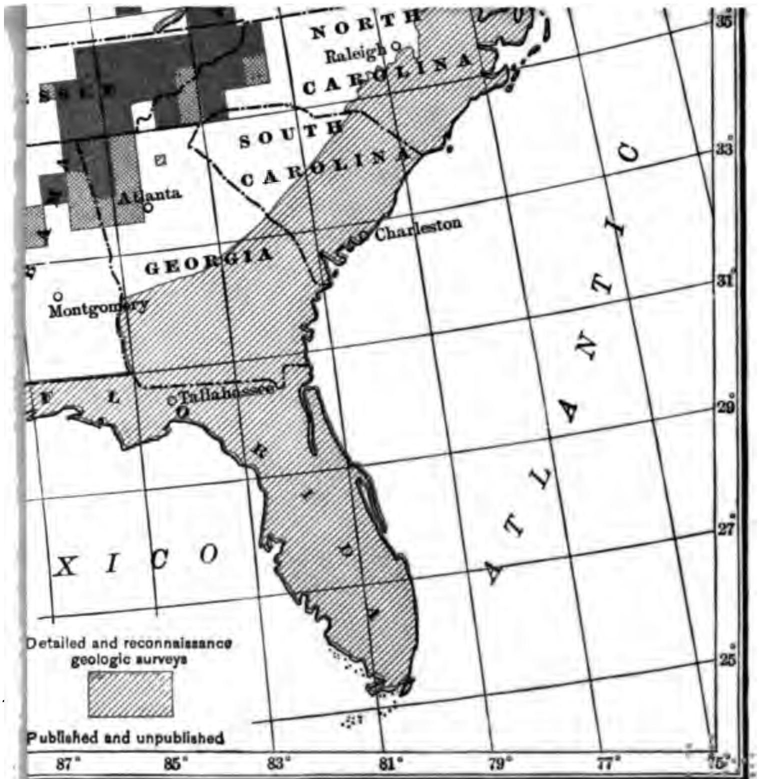
Geologic folio 155. Description of the Ann Arbor quadrangle, embracing an area 884.85 square miles in extent in the southeastern part of the Southern Peninsula of Michigan, the city of Ann Arbor being near its geographic center. General geology, marl deposits, and mineral waters described by I. C. Russell; topography and drainage, Quaternary geology, and water resources by Frank Leverett; peat deposits by Charles A. Davis; Paleozoic history by E. M. Kindle. In the preparation of this folio the Michigan State Geological Survey rendered much assistance. 15 folio pages of text and 3 maps representing topography, geology, and artesian waters.

Geologic folio 156. Description of the Elk Point quadrangle, comprising about 878 square miles in the Missouri Valley, on the western slope of the Mississippi basin, mainly in Union and Clay counties, S. Dak., but including also portions of Dixon and Dakota counties, Nebr., and Plymouth and Sioux counties, Iowa; by J. E. Todd. 8 folio pages of text and 3 maps of topography, geology, and artesian waters.

Geologic folio 157. Description of the Passaic quadrangle, comprising an area of about 905 square miles, the greater part of which lies in New Jersey, although Staten Island, the west end of Long Island, the south end of Manhattan Island, and several smaller islands belonging to New York are also included. The New York area is all in New York City; the New Jersey area includes the counties of Union and Essex and portions of Hudson, Passaic, Bergen, Morris, Middlesex, and Somerset counties; surveyed in cooperation with the State of New Jersey; by N. H. Darton, W. S. Bayley, R. D. Salisbury, and H. B. Kümmel. 27 folio pages of text, 3 maps—topography, areal geology, and surficial geology—a sheet of structure sections, and a sheet of illustrations exhibiting geologic features.

Geologic folio 158. Description of the Rockland quadrangle, comprising about 215 square miles (of which only about two-thirds is land) on the western side of Penobscot Bay, Maine; surveyed in cooperation with the State of Maine by Edson S. Bastin, under the supervision of George Otis Smith. 15 folio pages of text, 4 maps—topography, surficial geology, areal geology, and economic geology—and 1 sheet of structure sections.

Geologic folio 159. Description of the Independence quadrangle, an area 950 square miles in extent, located near the middle of the well-known Kansas-Oklahoma oil and gas field, of which it forms an important part; by F. C. Schrader. 7 folio pages of text; 3 maps, showing topography, areal geology, and structural and economic geology; and 1 sheet of structure sections; also sheet showing names that have been applied to the geologic formations *in this region* in various publications issued since 1866.


NORTH CAROLINA
Raleigh
SOUTH CAROLINA
Atlanta
Charleston
GEORGIA
Montgomery
Tallahassee
FLORIDA
XICO
ATLANTIC
Detailed and reconnaissance geologic surveys
Published and unpublished
35°
33°
31°
29°
27°
25°
87°
85°
83°
81°
79°
77°
75°

GIC SURVEYS

FIELD WORK BY THE DIRECTOR.

During the field season of 1907 the Director visited geologic, topographic, and hydrographic parties in California, coal-land classification parties in Wyoming, and the testing plants in Denver, St. Louis, and Norfolk. He also accompanied the Inland Waterways Commission on its Mississippi River trip and attended the public-land, irrigation, and mining congresses at Denver, Sacramento, and Joplin, respectively.

GEOLOGIC BRANCH.

ADMINISTRATION.

The geologic branch consists of four divisions, viz, (1) geology and paleontology, (2) Alaskan mineral resources, (3) mining and mineral resources, and (4) chemical and physical research.

Each division is in charge of an administrative chief, while the cooperation between the divisions and the coordination of the several lines of work are in the hands of the chief geologist, C. Willard Hayes. It is often to the advantage of the Survey to employ the members of one division in the work of another, and the form of the organization readily permits such transfer when exigencies demand it.

PUBLICATIONS.

The publications of the year prepared in the geologic branch included 9 geologic folios, 1 monograph, 2 professional papers, 18 bulletins, and the annual volume on mineral resources. Besides these a large number of papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies, and some original matter obtained incidentally during the course of the work and not appropriate for official reports has also been made the subject of unofficial publications. Such publications are ordinarily restatements of results in a more technical form, and are usually prepared by members of the Survey without compensation.

The progress of geologic mapping during the year, as represented in the publications of the Survey, is shown on Pl. I.

DIVISION OF GEOLOGY AND PALEONTOLOGY.

ORGANIZATION.

The scientific force of the division at the beginning of the year consisted of 50 geologists and paleontologists, 45 assistant geologists, and 26 junior geologists. During the year there were 7 resignations and 19 appointments, resulting in a net gain of 12, or a total of 133 at the end of the year. Of this number 85 were continuously employed; 33, carried on the per diem roll, gave only a portion of their time to Survey work; and 22 were not employed during the year. In addition to the above regular force 44 field assistants were employed for a portion of the year.

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Washington and met in conference those members of the federal organization that were most directly interested in the proposed investigation. At this meeting, which was held December 31, 1906, it was decided that a cooperative survey of the geology of the Coastal Plain should be undertaken, with special reference to the underground water resources of the region.

In accordance with the views expressed at the conference a supervising board was formed, with Prof. William Bullock Clark, of Johns Hopkins University, as chairman, the other members being the state geologists of the cooperating States and, from the National Survey, the chiefs of the geologic and water-resources branches, the geologist in charge of the section of paleontology, and the geologist selected to supervise the investigation.

The state geologist of each State has general supervision of the work in his State, and the chief geologist, chief hydrographer, and chief paleontologist of the federal Survey act in their respective official capacities. T. Wayland Vaughan, the geologist selected to supervise the investigation, has charge of the coordination of the work between the different States represented and of the geologic correlations.

Prof. W. B. Clark was in immediate charge of the Coastal Plain district extending from Massachusetts to and including North Carolina. Field operations were continued under his direction during the last fiscal year in New Jersey, Delaware, Maryland, Virginia, and North Carolina. He had the assistance of Messrs. B. L. Miller, E. W. Berry, L. W. Stephenson, M. W. Twitchell, and A. Bibbins and Miss Gardner.

In New Jersey the geology of certain portions of the Philadelphia quadrangle was revised in cooperation with the state geologist of New Jersey, preparatory to the publication of the Philadelphia folio, work on which was completed some years ago.

In Pennsylvania further work was done on the Cretaceous deposits, preparatory to the publication of the Philadelphia folio.

Work in Delaware has been confined largely to reconnaissance surveys in the Wilmington quadrangle. The Cretaceous, Tertiary, and Quaternary formations were provisionally platted as the result of work along the stream channels in the district.

In Maryland a systematic study of the Potomac floras, including the revision of the synonymy, was begun by Mr. Berry.

The work in Virginia consisted of a study of the stratigraphy and a laboratory study of the Tertiary fossils. Particular attention was given to the stratigraphy of the Tertiary formations. The leading divisions recognized in Maryland were found, and their extension across the State was mapped in a preliminary way. Mr. Berry began an exhaustive study of the Potomac floras in conjunction with the

GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

New England.—The State of Maine cooperated in geologic work to the extent of $2,100. The detailed geologic survey of the Eastport 30-minute quadrangle was continued by Edson S. Bastin, assisted by C. L. Breger. Prof. Henry S. Williams cooperated in investigations of Devonian paleontology and stratigraphy.

The detailed mapping of the areal geology of the Frenchman Bay quadrangle was continued by Charles W. Brown, and a study of the hard-rock road materials of Maine was made by Henry Leighton, under the direction of Mr. Bastin. The Office of Public Roads of the United States Department of Agriculture cooperated in the testing of samples and in the publication of the report.

During the winter Prof. H. S. Williams, assisted by C. L. Breger, continued the preparation of a manuscript on the Chapman fauna of Maine. A paper entitled "Revision of the mollusk genus *Pterinea*" was published in April by the United States National Museum preliminary to the publication of this monograph.

Brief studies of some of the molybdenite deposits of Maine were made by Frank L. Hess.

A detailed study of the Branford Light-House Point area, Connecticut, was made under Prof. Herbert E. Gregory's direction by Freeman Ward.

Field work on the Ware and Quinsigamond (Mass.) quadrangles was completed by Prof. B. K. Emerson. The text of the Ware folio is in final form, and that of the Quinsigamond folio is nearly ready. The glacial deposits of these quadrangles have been studied by W. C. Alden, and chapters on the Pleistocene geology for the folios have been prepared by him. Professor Emerson also compiled a general geologic map of the States of Massachusetts and Rhode Island, on the scale of 4 miles to the inch. The map is ready for publication and a brief text which will accompany it is well advanced.

All the granite quarries in Vermont, 79 in number, were visited by T. Nelson Dale, and similar work was begun in Connecticut. Mr. Dale also completed a bulletin on the chief commercial granites of Massachusetts, New Hampshire, and Rhode Island (Bulletin 354) and a bulletin on the granites of Vermont, an abstract of which he has furnished for publication in the report of the state geologist of Vermont for 1908.

Atlantic Coastal Plain.—A geologic study of the Atlantic Coastal Plain is being carried on in cooperation with the official Surveys of the various States concerned. Although the need for such work was long recognized, the plans for it were not perfected until about a year ago, when, in response to an invitation sent out by the Director of the National Survey, the state geologists from the various States came to

Washington and met in conference those members of the federal organization that were most directly interested in the proposed investigation. At this meeting, which was held December 31, 1906, it was decided that a cooperative survey of the geology of the Coastal Plain should be undertaken, with special reference to the underground water resources of the region.

In accordance with the views expressed at the conference a supervising board was formed, with Prof. William Bullock Clark, of Johns Hopkins University, as chairman, the other members being the state geologists of the cooperating States and, from the National Survey, the chiefs of the geologic and water-resources branches, the geologist in charge of the section of paleontology, and the geologist selected to supervise the investigation.

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The work in Virginia consisted of a study of the stratigraphy and a laboratory study of the Tertiary fossils. Particular attention was given to the stratigraphy of the Tertiary formations. The leading divisions recognized in Maryland were found, and their extension across the State was mapped in a preliminary way. Mr. Berry began an exhaustive study of the Potomac floras in conjunction with the

Maryland materials, with the idea of making a complete revision of the synonymy and carefully determining the horizons from which the various forms come.

The North Carolina work was continued by Doctor Clark, in cooperation with Messrs. Miller, Berry, Twitchell, and Stephenson, and Miss Gardner. Extensive collections were made from the Lower Cretaceous beds, and the deposits have been correlated with those of regions farther north. A preliminary map showing the distribution of the several formational units has been been prepared, and also a report on North Carolina Coastal Plain stratigraphy.

T. Wayland Vaughan was in immediate charge of the Coastal Plain district extending from the North Carolina-South Carolina line southward.

In South Carolina, in company with Earle Sloan, state geologist of South Carolina, Mr. Vaughan reviewed the Tertiary stratigraphy of the State, making at numerous localities collections of fossils, which were subsequently studied, in order to establish geologic correlations between South Carolina and adjoining States. L. W. Stephenson spent several weeks in South Carolina for the purpose of correlating the Cretaceous formations of the State with those of the other Coastal Plain States and of determining the Eocene or Cretaceous age of certain beds. Considerable progress was made in the study of the geology of South Carolina, and as a result of the cooperative work Mr. Sloan will soon issue a report on the Coastal Plain formations of that State. This report will be followed by a special report on the underground waters of the State, for which most of the data have already been collected.

An arrangement, contingent on receiving the necessary appropriations, was made with S. W. McCallie, state geologist of Georgia, for the detailed study of the Coastal Plain of Georgia, with especial reference to underground water resources. In accordance with this arrangement L. W. Stephenson, on the part of the United States Geological Survey, spent some time in the study of the stratigraphy and correlation of the Cretaceous formations. The Georgia Geological Survey assigned Otto Veatch as its representative in the work. Mr. Vaughan, in company with Earle Sloan, visited critical localities in Georgia near Savannah River.

An agreement was made between the Director of the United States Geological Survey and E. H. Sellards, state geologist of Florida, for cooperative work in that State. According to this arrangement Mr. Sellards and an assistant, Herman Gunter, conducted the field researches regarding the underground waters in 16 counties, comprising the central portion of the State, while the underground water investigations in the remainder of the State, as well as the stratigraphic work, were carried on by representatives of the United States

Geological Survey. Mr. Vaughan supervised the investigation on behalf of the federal Survey, and F. G. Clapp and George C. Matson were assigned to the field work and completed it as planned.

Mr. Vaughan had several conferences with Prof. Eugene A. Smith, state geologist of Alabama, with reference to stratigraphic correlations, and Professor Smith was also visited by Messrs. Clapp and Stephenson for similar consultations. A few of the more important exposures of Cretaceous formations were visited by Mr. Stephenson for the purpose of comparing the geologic sections in the more eastern States with the section in Alabama.

In Texas Alexander Deussen undertook field work and the preparation of a report on the stratigraphy and underground waters of the region extending eastward from the Sabine to the Brazos and lying south of a line crossing Marion, Upshur, Wood, Van Zandt, and Kaufman counties. The field work for this area was completed and the report is almost ready for publication.

A preliminary study was made by L. W. Stephenson, under the supervision of T. W. Stanton, of collections of Cretaceous fossils from North Carolina, South Carolina, Georgia, and Alabama, obtained in the course of work on the stratigraphy of the Atlantic Coastal Plain.

The stratigraphy and paleontology of a part of Staten Island, New York, was investigated by E. C. Jeffrey and Arthur Hollick under the direction of F. H. Knowlton, and much valuable material bearing on the stratigraphy of the Cretaceous formations of the Atlantic coast was obtained.

Northern Appalachian region.—A detailed study of the Dalmanellas of the Devonian of New York was made by H. S. Williams to illustrate the amount and kind of modification of species coordinate with geologic sequence in time. A preliminary paper by Professor Williams on the Dalmanellas of the Chemung formation was published in April, 1908, by the National Museum.

A paper on the correlation of the Devonian section of the Tioughnioga and Chenango valleys with the standard Ithaca section was finished in August, 1907, but was withheld from publication awaiting the settlement of questions of nomenclature for the Watkins Glen and Catatonk quadrangles.

Geologic work in Pennsylvania was done in cooperation with the State, which made an appropriation of $5,500 for this purpose. Detailed areal and economic surveys of the Carnegie and Warren quadrangles were completed, and the text of the Warren folio has been submitted. The areal survey of the Claysville quadrangle was completed and areal work was carried on in the Sewickley quadrangle. The work on the Clarion quadrangle was completed and additional studies were made in the Johnstown, Punxsutawney, and Houtzdale quadrangles. The work in Pennsylvania was in charge of George H. Ashley, with whom were associated George C. Martin, Charles Butts, M. J. Munn, Frederick B. Peck, W. C. Phalen, and Edwin F. Lines.

A. C. Spencer continued the study of the magnetite deposits of the Cornwall type in Dauphin, Lancaster, and York counties, and the final report on this work is ready for publication.

The mapping of the New Jersey Highlands was continued by W. S. Bayley, the field work being completed for the Ramapo quadrangle. Doctor Bayley spent the remainder of the field season in revising the mapping of the Raritan quadrangle and in extending the mapping of the Easton quadrangle west of Delaware River in Pennsylvania.

George W. Stose completed and transmitted for publication the Mercersburg-Chambersburg (Pa.) folio, completed the field work in the Pawpaw and Hancock (W. Va.-Md.-Pa.) quadrangles and began preparation of the folio in cooperation with the Maryland Geological Survey, and partly surveyed the Carlisle (Pa.) quadrangle.

Frank W. De Wolf nearly completed an economic bulletin and a folio for the Newcastle (Pa.) quadrangle.

E. O. Ulrich spent the month of July in the Champlain and Mohawk valleys in New York. Through the courtesy of Dr. John M. Clarke, state geologist of New York, Dr. Rudolph Ruedemann, of his staff, was detailed as guide and associate to Mr. Ulrich in a study of typical outcrops in these classic areas of American early Paleozoic stratigraphy. During about half of the time Prof. H. P. Cushing, also of the New York State Survey, accompanied Messrs. Ruedemann and Ulrich. It is believed that this association of state and federal geologists will lead to a clearer appreciation of the composition of the New York section and to greater exactitude in correlations with it.

The month of August was devoted to a continuation of stratigraphic studies in the Mississippi and Appalachian valleys, begun several years ago. Those in the Appalachian area were resumed in May, 1908. In the early part of this month Mr. Ulrich, in association with Mr. Stose, extended these studies through the Carlisle (Pa.) quadrangle, and thence northward to Harrisburg, Pa.

Southern Appalachian region.—In the Cowee (N. C.) quadrangle field work, done for the most part jointly with the state Survey, consisted in the examination of deposits of ruby, mica, and kaolin, by D. B. Sterrett, together with a review of the base of the Ocoee strata by Arthur Keith.

In the Morgantown (N. C.) quadrangle field work included the mapping of the monazite and gold-bearing sands, mainly by Mr. Sterrett. In the Dahlonega (Ga.) district the mapping of the auriferous gravels and similar deposits was completed by Mr. Keith.

For the determination of the sequence of gneisses and schists in the Dahlonega, Suwanee, and Dalton quadrangles, in Georgia, and the Walhalla quadrangle, in South Carolina, a brief reconnaissance was made by Mr. Keith.

W. C. Phalen carried on revisional work in the Ellijay (Ga.) quadrangle and in adjacent portions of the Suwanee and Dalton quadrangles.

The iron-ore deposits that appeared to be of economic interest were visited and brief accounts of them were prepared for publication in Bulletin 340 (Contributions to Economic Geology, 1907, Part I). The known bauxite deposits in Georgia, Alabama, and Tennessee were visited by Messrs. Hayes and Phalen, partly in the interest of work for the annual report on mineral resources and partly to extend the knowledge of the geology of the deposits.

Work was continued in the Birmingham (Ala.) district by Mr. Butts, in the preparation of folios, special reports, and a paper on the coal fields of Alabama.

Selected outcrops of Ordovician and late Cambrian rocks in the Appalachian Valley between Clinchport, Va., and Knoxville, Tenn., were studied by E. O. Ulrich and R. S. Bassler. The immediate object of these investigations was to determine the causes of the well-known local variations in lithologic and faunal characters of the great series of dolomites and limestones commonly referred to as the Knox dolomite. In June an areal survey was made of the Woodbury (Tenn.) quadrangle by Messrs. Ulrich and Bassler.

GEOLOGIC WORK IN CENTRAL STATES EAST OF 97°.

Areal and economic surveys in the coal fields of southern Illinois were continued in cooperation with the state Geological Survey. T. W. Savage, Stuart Weller, and J. H. Udden were employed on this work by the State, and Frank W. De Wolf, E. C. Lines, and David White by the federal Survey. Three quadrangles, the Belleville, Breese, and Galatia, were surveyed with the assistance of members of the state Survey. These quadrangles form parts of two belts of 15-minute areas, which will extend across the State at a distance of 36 miles apart. In connection with the field work systematic collection and analysis of face samples from shipping coal mines has been carried on. Preliminary reports on these quadrangles have been submitted, and final reports on the Belleville and Breese quadrangles are in preparation. A bulletin on the Peoria quadrangle was submitted by the state Survey, in accordance with an agreement made in the previous year.

The results of the Illinois surveys will be available for publication in folio form after the general correlation studies planned for the following year have been completed.

A reconnaissance study of the stratigraphy and structure of the Henderson (Ky.) and the Evansville (Ind.) coal fields and of part of the southern Illinois field was made by George H. Ashley and Frank W. DeWolf.

As part of the cooperation with the state Survey of Illinois the field study of the fossil floras of the basal "Coal Measures" in that State was continued by David White, who at the same time worked out the age and number of the coals laid down in the early Pennsylvanian basin. During the two months available this work was extended along the greater part of the western border of the coal field.

In Arkansas work was done by the United States Geological Survey in cooperation with the Geological Survey of Arkansas, Prof. A. H. Purdue, state geologist, being in charge of the work. The mapping of the slates of Arkansas and of such part of the Caddo Gap quadrangle as time would permit, for folio publication, was the object in view. E. O. Ulrich accompanied Professor Purdue to Crystal Springs, Montgomery County, for the purpose of making paleontologic studies to determine the age of the rocks in the slate region.

A reconnaissance of portions of the Cherokee and Creek Nations was made by C. E. Siebenthal to ascertain more exactly the relations of the Pennsylvanian formations in the Wyandotte (Okla.-Mo.), Independence (Kans.), and Muskogee (Okla.) quadrangles. Mr. Siebenthal subsequently took up the collection of lead and zinc statistics for the calendar year 1907, for publication in the annual report on mineral resources, and carried on this work throughout the remainder of the fiscal year.

Previous study of the critical relations of the several parts of the Keewatin and Labradoran glacial formations on the north and west sides of the Driftless Area in Wisconsin, Minnesota, and Iowa was continued by Frank Leverett, who during the winter prepared a report of progress on this work and continued the preparation of manuscript on the formations of the Michigan glacial lobe.

Areal glacial work was continued by W. C. Alden in Wisconsin, chiefly in the townships of Monroe, Bellville, Cross Plains, Baraboo, Denzer, Dells, and Briggsville, in the south-central part of the State. In June, 1908, Mr. Alden resumed field work in northern Illinois on subjects related to his previous work in Wisconsin.

Supplementary studies of the area of the Michigan glacial lobe and related tracts were made by Frank B. Taylor, who directed his attention particularly to the former beach lines and other lacustrine phenomena. Mr. Taylor made some studies in correlation on the south side of Lake Erie in Ohio and New York, and, without expense to the Survey, extended his examinations to related phenomena in Ontario. His office work was devoted chiefly to the preparation of manuscript on the lacustrine formations associated with the Michigan glacial lobe.

Careful spirit-level surveys of the elevated beach lines of the glacial Lake Michigan were made by J. W. Goldthwait to determine the nature of the former movements of the lake level. This work was done in close association with and supplementary to that of Messrs. Taylor and Leverett. The work of Messrs. Leverett, Alden, Taylor, and Goldthwait was carried on under the general supervision of Prof. T. C. Chamberlin.

C. R. Van Hise and C. K. Leith gave a large amount of time during the winter to the completion of the final monograph on the Lake Superior region. Doctor Van Hise devoted the months of July and August to this work, which involved the writing of several new chapters, the radical revision of others, a large amount of chemical and physical investigation of the ores and the iron formations, and the direction of a draftsman continuously during the year in the revision of maps.

An extensive series of physical and chemical tests of the iron ores of the Lake Superior region was made by W. J. Mead in connection with the discussion of the origin of the iron ores forming a chapter in the forthcoming monograph.

A study of the physiographic features of the Lake Superior region was made by Lawrence Martin in connection with the preparation of a chapter on the surface features of the region for the monograph.

Some corrections of the map in the Mesabi iron region were made by Doctor Leith, who also conferred with Mr. Mead in reference to the latter's work.

A topographic and geologic model of the Lake Superior region has been prepared under direction of C. K. Leith and Lawrence Martin, by E. H. J. Lorenz, mechanician and model maker, of the University of Wisconsin. A reproduction of a large photograph of this model, which shows many interesting features, will be included in the monograph.

A. N. Winchell gave some time to the collection of available information concerning the petrography of Keweenawan lavas and intrusives.

W. S. Bayley, of the University of Illinois, gave a little time to the revision of the chapter and map on the Calumet trough of Michigan for this monograph.

The summaries of literature for a bulletin on the North American pre-Cambrian rocks were brought up to January 1, 1908, by Doctor Leith, and a revision of the general discussion was made by Doctors Van Hise and Leith. This work touches closely subjects discussed by them at a conference in Chicago on the geologic map of North America with Messrs. Chamberlin, Willis, Adams, Brock, and Miller.

Rocky Mountain region.—M. R. Campbell continued in charge of the coal-land classification and valuation in the Western States, carrying on this work in addition to supervising the surveys of various oil and gas fields in the United States.

The plans provided for the classification of about 20,000 square miles of supposed coal territory in the Rocky Mountain region. To carry out this work sixteen field parties were organized, and groups of parties working in close proximity were placed in charge of subordinates, C. A. Fisher having direct supervision of five parties in south-central Montana and north-central Wyoming, and A. C. Veatch having charge of four parties in south-central Wyoming. The other parties worked independently, with only such supervision as Mr. Campbell was able to give them.

A party under the direction of Max W. Ball carried on a geologic survey of the western part of the Little Snake River coal field, in southern Wyoming, beginning at Rawlins, on the Union Pacific Railroad, and extending southward to the Colorado line.

A party under the direction of W. R. Calvert made a survey of the Lewistown (Mont.) coal field, from July 1 to October 1, 1907. Mr. Calvert's work extended from the Great Falls coal field on the west, which was examined by Mr. Fisher during the previous year, to a point as far east of Lewistown as the workable coal beds appeared to continue.

A party under the direction of Arthur J. Collier surveyed the Miles City (Mont.) coal field, beginning work before the 1st of July and continuing until September 5, 1907, when Mr. Collier was detailed to examine mineral claims in the national forests, and Carl D. Smith assumed charge of the party in the Miles City field.

A party under the direction of Hoyt S. Gale made an examination of the northern rim of the Uinta coal basin in Colorado and Utah, working from the Danforth Hills in Colorado westward as far as Vernal, Utah. At the close of this examination Mr. Gale crossed the Uinta Mountains and made a brief survey of the Henrys Fork coal field, which lies partly in Utah and partly in Wyoming.

A party under the direction of James H. Gardner made an examination of the eastern rim of the San Juan River coal basin of northwestern New Mexico and southwestern Colorado, from July 1 to October 5, 1907. Most of this work was done in a field already described by Mr. Schrader, but the reexamination was made necessary by the fact that in the previous work the lands had not been classified according to legal subdivisions. On February 15 Mr. Gardner was again detailed to New Mexico to make an examination of several isolated coal fields in the Rio Grande Valley. From February 15 to

July 1 he was engaged in this work, examining in that time the Carthage, Hagan, Cerrillos, Santa Fe, Glorieta, and Cabezon fields.

C. A. Fisher was placed in charge of five parties operating in the vicinity of Billings, Mont. The heads of these parties were Messrs. Calvert, Stone, Woolsey, Washburne, and Woodruff. From July 1 to October 31 Mr. Fisher was engaged in supervising the work of these parties.

A party under the direction of Willis T. Lee was engaged in the examination of the Grand Mesa coal field of Colorado from July 1 to September 30, 1907. This field is the eastern continuation of the Book Cliffs coal field, examined during the previous year by George B. Richardson. From October 1 to October 7 Mr. Lee was engaged in the study of the " Red Beds " in the vicinity of Las Vegas, N. Mex.

A party under the direction of George B. Richardson made a survey of the coal fields of southwestern Utah, including the so-called anthracite field of New Harmony and the bituminous fields of the Colob Plateau. Mr. Richardson was engaged in this work from July 1 to October 1, after which he proceeded to Texas and continued his work in the El Paso and Van Horn quadrangles.

A party under the direction of A. R. Schultz was engaged in the survey of the Rock Springs (Wyo.) coal field from July 1 to December 23, 1907. The geologic work in this field was carried on in conjunction with a resurvey of the land lines of a part of this region and the inspection of land surveys in another part of the same region under the General Land Office.

A party under the direction of E. Wesley Shaw was engaged in the survey of the Glenrock (Wyo.) coal field from July 1 to October 16, 1907.

A party under the joint direction of Carl D. Smith and Prof. A. G. Leonard, state geologist of North Dakota, made a survey of the Sentinel Butte coal field of North Dakota and eastern Montana. Professor Leonard was able to be with the party only a few weeks, and consequently the major portion of the work devolved upon Mr. Smith. He was engaged in this work from July 1 to September 5, when, owing to the transfer of Mr. Collier to other fields of work, Mr. Smith was detailed to Miles City to continue the unfinished work in that field.

A party under the direction of E. E. Smith made a geologic survey of the Great Divide Basin coal field of Wyoming from July 1 to November 15, 1907. The work of this party connects with that of Mr. Ball on the south, that of Mr. Schultz on the west, and that of Mr. Veatch, done during the previous year, on the east.

A party under the direction of R. W. Stone made a geologic survey of a large territory north and west of the Crazy Mountains, Montana, from July 1 to October 18, 1907. This work was done on the supposition that large bodies of coal occur in this region, but the work of Mr. Stone shows that coal of workable thickness is entirely absent, and that there is no reason for regarding this area as a coal field.

A party under the direction of Joseph A. Taff made a geologic survey of the Sheridan (Wyo.) coal field from July 1 to October 31, 1907.

A. C. Veatch was placed in charge of the parties of Messrs. Schultz, Shaw, Smith, and Ball in central Wyoming. In addition to supervising the geologic work of these parties Mr. Veatch was authorized by the General Land Office to make a resurvey of a small area north of Rock Springs and to inspect certain contract surveys in the same locality. This work engaged Mr. Veatch's attention from July 1 to September 19, 1907, when he was transferred to the office of the President to investigate the mining laws of Australasia.

A party under the direction of C. W. Washburne made a geologic survey of the coal fields on the northeast side of the Bighorn Basin, Wyoming, from July 1 to October 31, 1907. This work, although principally in Wyoming, extended northward from Montana for 20 or 30 miles, including all of the so-called Bridger coal field in the valley of Clark Fork.

Carroll C. Wegemann was engaged during the field season of 1907 and much of the office season of 1907–8 as an assistant to Arthur J. Collier and Carl D. Smith. On April 20, 1908, Mr. Wegemann was instructed to proceed to Miles City, Mont., and join a party from the Forest Service in the examination and classification of coal lands in the Otter National Forest. This work occupied his time until May 29, when he returned to Helena, Mont., for the purpose of collecting data regarding the land surveys of the Bull Mountain region. Mr. Wegemann completed this work by June 10, and then proceeded to Sheridan, Wyo., to assist Mr. Gale in the survey of the Buffalo coal field.

A party under the direction of L. H. Woolsey made a geologic survey of a portion of the Musselshell Valley, including the southern part of the Bull Mountain field, Montana, from July 1 to October 29, 1907. A large part of the area examined was found to be barren of workable coal beds, so that the energy of the party was largely centered on the Bull Mountain field, which contains a great many coal beds and doubtless will become an important coal producer. In order to complete the survey of this field at an early date, so that the lands might soon be restored to coal entry, R. W. Richards, who has been associated with Mr. Woolsey in the work, returned to the field on May 1, 1908, and with a small party continued the surveys of the previous season. This work is in progress July 1 and will soon be completed.

A party under the direction of E. G. Woodruff made a geologic survey of the coal fields on the southwest side of the Bighorn Basin, Wyoming, including the Red Lodge field in Montana.

T. W. Stanton, paleontologist, spent the months of July, August, and September in field work on the stratigraphy and paleontology of the coal-bearing formations of the Rocky Mountain region, in cooperation with the geologic parties that were doing areal and economic work in the various coal fields. Visits of sufficient length to determine the important features of the sections were made to the parties near Rawlins, Rock Springs, Casper, Sheridan, and Cody, in Wyoming, and near Red Lodge, Crazy Mountains, and Judith Mountains, in Montana.

F. H. Knowlton, assisted by A. C. Peale, spent the field season in the study of stratigraphic and paleontologic problems along Missouri and Yellowstone rivers in North Dakota and Montana, in connection with the coal work, procuring much paleobotanic material for use in the correlation of various Upper Cretaceous and Tertiary formations. Mr. Knowlton also visited the Bighorn Basin, Wyoming, and the northern side of the Crazy Mountains, Montana, studying the stratigraphy and paleontology of these regions.

A detailed survey of the central pre-Cambrian area of the Black Hills, South Dakota, was begun by A. Johannsen. The areal distribution of the slates, schists, and intrusives of a portion of the area was mapped and a large number of specimens were collected. The key to the structure was obtained.

Some revision work in the Black Hills was done by N. H. Darton, in the Hermosa, Rapid, and Deadwood quadrangles.

During the field season of 1907 S. F. Emmons, under leave of absence without pay, took charge of a geologic survey of the important copper-mining district of Cananea, in Sonora, Mexico, not far south of the international boundary. The product of this district is entirely tributary to the United States and its geologic structure presents some phenomena not hitherto observed in mining districts within our boundaries, so that its study serves to round out investigations of natural processes of ore distribution that have been carried on by this Survey.

Whitman Cross did no field work during the summer of 1907, being absent for several months on leave of absence without pay. He was assisted by Howland Bancroft from December 1 to June 30 in office work connected with the Ouray and Engineer Mountain folios of Colorado.

Work was resumed by Mr. Cross in June, 1908, on the geology of the San Juan region, Colorado, particularly on that of the Lake City and San Cristobal quadrangles, where work had been done in previous seasons. The survey of the former area will be completed during the coming season, and that of the latter will be carried as far as possible toward completion.

Frank C. Schrader spent several months in examining mining claims in the national forests of Colorado and occupied the remainder of the year in field and office work on a report on the mineral deposits of western Arizona.

F. B. Weeks continued the reconnaissance of the western phosphate field in Idaho, Wyoming, and Utah, and spent about a month at Osceola, Nev., in a study of the mineral resources of the Osceola and Tungsten mining districts. He also, in company with V. C. Heikes, devoted a few days to a reconnaissance of the Fort Hall mining district, Idaho.

In Nevada F. L. Ransome revisited the Goldfield and Bullfrog districts to gather supplementary data. Reports embodying these data were nearly completed during the year and require only the insertion of information afforded by recent mining developments to be ready for publication. The Goldfield report is by Mr. Ransome, and the Bullfrog report by Messrs. Ransome, W. H. Emmons, and G. H. Garrey.

The final report on the geology and ore deposits of the Cœur d'Alene district, Idaho, by F. L. Ransome and F. C. Calkins, was completed and submitted for publication in August, 1907. It is now available for distribution.

A detailed study was made of the region in the vicinity of the Canadian Pacific Railway between Castle Mountain, Alberta, and Field, British Columbia, by Charles D. Walcott and L. D. Burling. The sections of Castle Mountain, Lake Louise, Mount Bosworth, and Mount Stephen were measured in detail, and numerous collections of fossils were obtained, which have an important bearing on the early Paleozoic succession in Montana, Idaho, and Utah. During the field season of 1908 Doctor Walcott will continue this investigation by making a detailed study of the section along the line of the forty-ninth parallel between Montana and British Columbia, in an attempt to correlate, if possible, the rocks studied by him in Canada with those in the United States. During September, 1907, Doctor Walcott spent two weeks in making a collection of Cambrian fossils in southeastern Idaho. The office work of Doctor Walcott for the fiscal year ended June 30, 1908, has been the completion of a monograph on the Cambrian Brachipoda.

The pre-Cambrian rocks of the Laramie Hills of southeastern Wyoming were studied in detail and mapped within the limits of the Sherman quadrangle by Eliot Blackwelder. It is believed that these studies will materially aid an understanding of the ancient rocks that occur generally in the cores of many western mountain ranges. An examination of similar rocks in the Laramie quadrangle was made by Mr. Blackwelder, and the final manuscript for the Laramie-Sherman folio was submitted for publication.

Detailed mapping of the geology of the Shasta County copper region, in California, begun by L. C. Graton in 1906, was extended by B. S. Butler during two months of the summer of 1907, when Mr. Graton was on leave in Mexico. The mapping was completed in November, and Mr. Graton completed the underground investigation of the mines in January. Progress has been made on the final report.

The investigation of the copper resources of the country, which was begun by Mr. Graton in 1906, was continued during the year, and trips were made to nearly all the important copper districts not already visited.

The final joint report on the mining districts of New Mexico by Messrs. Lindgren, Graton, and Gordon was carried nearly to completion.

F. C. Calkins continued detailed areal mapping in the Philipsburg district, Montana. The work has been virtually completed, but it was determined that a visit to the field in company with a paleontologist would be necessary for the correlation of the Mesozoic formations.

W. H. Emmons, after completing the survey of the metalliferous deposits of the Philipsburg quadrangle, made a study of the gold deposits of the Little Rocky Mountains, Montana.

J. M. Boutwell was engaged in the preparation of the annual reports on the production of zinc, lead, and quicksilver during the year 1906. He also visited the Park City mining district, Utah, and procured valuable data on mining developments there during the last year. In the office he has since prepared sections on gold-bearing gravels in Calaveras County, Cal., and resumed the preparation of the report on the Park City mining district, Utah, with a view to completing it this year.

T. Wayland Vaughan resurveyed a portion of the Brackett (Tex.) quadrangle. The survey of this area is now completed and the manuscript, including text and geologic map, will soon be submitted for publication as a folio of the Geologic Atlas.

Pacific coast.—Detailed surveys were made of the Coalinga oil district, Fresno County, and the region as far south as Dudley, Kings County, Cal., by Ralph Arnold, assisted by Robert Anderson. Special attention was given to the details of the underground geology in the proved territory in order to discover the conditions of the occurrence of petroleum in this particular field, and also to a study of the structure and stratigraphy of the adjacent regions with a view to obtaining information as to the extension of the productive area, so as to decrease the cost of development by reducing the number of dry holes drilled. A study of the paleontology, which bears a peculiarly important relation to the interpretation of the structure and stratigraphy in this district, was carried on simultaneously with the strictly economic work. Both a preliminary and a final report on the district were prepared. A continuation southward to Sunset, Kern County, of the investigations begun in the Coalinga district will be carried forward during the field season of 1908. Mr. Arnold also spent a short time in the Santa Cruz quadrangle, doing some supplementary mapping and attending a field conference with George D. Louderback relating to the Franciscan-Knoxville question, and made a brief visit to the Miner ranch oil field, in Contra Costa County, on which he prepared a short report.

A bulletin on the magnesite deposits of California was prepared by Frank L. Hess and is in course of publication.

The detailed mapping of the Riddles quadrangle, in Oregon, was completed and work on the Grants Pass quadrangle was begun by J. S. Diller, assisted by G. F. Kay. Mr. Diller also investigated, for the Forest Service, the coal in the northern part of the Siskiyou National Forest and reported later that a large number of coal claims that have been taken up are nonworkable under present conditions. In response to numerous requests by citizens of Oregon, a reconnaissance was made by Mr. Diller about Mount Bolivar, in Douglas County, to determine the mineral character of the land. With James Storrs, Mr. Diller visited Oroville, Cal., to study the Mesozoic plant beds of that region. This study was continued in Curry County, Oreg., and Trinity and Tehama counties, Cal., to determine more closely the epoch of greatest deformation and mineralization in the Klamath Mountains, where mining is extensive. In studying the asbestos deposits of the United States Mr. Diller visited Sall Mountain, Georgia; Rocky Mount and Bedford, Virginia; Lowell, Vermont; Casper Mountain, Wyoming; Grand Canyon, Arizona; and Towle, California.

The investigation of Pleistocene glaciation in the Sierra Nevada has been continued by Willard D. Johnson, attention being given to contemporary deformation and volcanism as locally complicating and radically affecting the glacial record. The resulting studies have been carried far enough, it is believed, to warrant a general statement of results, and a report is now well advanced.

In June, 1907, Prof. James Perrin Smith spent three weeks in the West Humboldt Range of Nevada, studying the Triassic stratigraphy and collecting Triassic fossils to illustrate a monograph. Later he visited the Klamath Mountains of Shasta County, Cal., and spent three weeks in collecting Upper Triassic fossils. In Nevada he collected several new species of Middle Triassic cephalopods, which have been included in a monograph on that fauna. In California Professor Smith found several new species of cephalopods and discovered in the Upper Triassic limestone a coral reef that forms an important lithologic horizon and gives a new element to the faunas of that series in America.

Progress was made in arranging the material collected and in preparing a monograph on the marine Middle Triassic faunas of America, which is not completed.

The work of Waldemar Lindgren has consisted largely of administrative duties in connection with the section of metalliferous deposits and the section of metal statistics (the larger part of the time having been given to the latter), and with the examination of mining claims in national forests. The remaining time has been given to geologic field work and office work and to testimony before the United States court in connection with prosecutions instituted by the Post-Office Department for the abuse of mailing privileges.

In cooperation with the technologic branch N. H. Darton made an examination of the geology of Portland, Oreg., and Tacoma and Seattle, Wash., especially in relation to structural materials.

GENERAL GEOLOGIC AND PALEONTOLOGIC WORK.

The important investigations relating to river hydraulics with special reference to laws of detrital load were continued by G. K. Gilbert in cooperation with the water-resources branch. In studying the obstruction of Sacramento River, rough measurements were made of the pits formed by past hydraulic-mining operations, from which estimates were made of the amount of material removed in the basin of Yuba River. In order to elucidate the conditions affecting the surcharged river and the possibilities of its treatment, the relations of load to gradient and volume in stream flow were studied. This work, the application of which is much broader than the specific and local problems here involved, was carried forward in the laboratory of the University of California. The results thus far obtained include the relations of load to slope, of load to discharge, of load to coarseness of detritus, and of load to form of cross section of channel.

The partial submergence of shell mounds about the shores of San Francisco Bay, as determined by the University of California, led to an investigation by Mr. Gilbert of such mounds near the mouth of Sacramento River, in order to discover if such subsidence had taken place there.

Prof. Harry Fielding Reid has continued to collect all available data relative to earthquakes in the United States. The International Seismological Association, of which this country is a member, held its first general assembly last September at The Hague. Professor Reid attended the meeting as delegate from this country. The assembly voted to continue Strassburg as the location of its central bureau for the next four years and elected Professor Schuster, the delegate from Great Britain, as the president of the association for the same period. A number of important scientific questions were debated and the central bureau presented a compilation of all the earthquakes in the world for the year 1904. The association promises to be a great stimulus to seismologic investigation.

W. H. Dall identified between 3,000 and 4,000 fossils for field parties of the Survey. He also continued his studies of the post-Eocene fauna of the Pacific coast. The report on the Miocene of Oregon is now in course of publication.

George H. Girty, in addition to preparing reports on material referred to him, made preliminary studies of some Arkansas collections of fossils and described the fauna with which the phosphates were associated in Idaho and Utah. He spent a month in the study of the types of Winchell's Carboniferous species preserved at Alma and Ann Arbor, Mich., and devoted another month to collecting paleontologic and stratigraphic data in the Carboniferous rocks of Arkansas and Kansas.

From July 1 until August 15 T. Wayland Vaughan was on leave of absence without pay, studying Paleozoic fossil corals for the New York State Museum, in accordance with an arrangement between the director of that museum and the Director of the United States Geological Survey. In April, 1908, in response to an invitation from the Carnegie Institution of Washington, he undertook special investigations of the geology of the Florida keys and reefs, of the near-shore bottom deposits of the ocean, and of the recent corals of the region, with reference to environmental conditions, and initiated a series of experiments for the purpose of procuring data on the factors influencing variation and determining distribution, the information obtained from the last two investigations to be used as a basis for the reconstruction of the physical conditions under which fossil faunas lived. Valuable information was procured on each of the subjects to which attention was paid.

Work in vertebrate paleontology has been continued under the direction of Prof. Henry Fairfield Osborn. The monograph on the Ceratopsia, begun by O. C. Marsh, continued by J. B. Hatcher, and edited and completed by R. S. Lull, has been published. The monograph on the Stegosauria, originally assigned to F. A. Lucas, but transferred to R. S. Lull, is slowly progressing through simultaneous studies in the National, Yale, and American museums. No allotment has been made by the Survey during the present year for the work of Professor Lull.

Except during two periods of absence abroad and in the field, Professor Osborn has been engaged continuously in completing the monograph on the titanotheres. The study of the stratigraphy of the Eocene of the Rocky Mountain region, reported last year as under way, has been finished, Professor Osborn having made a special journey to the Washakie to complete his observations. This stratigraphic and paleontologic correlation forms the subject of a special paper now in course of publication by the Survey and will contribute to the geologic section of the titanothere monograph. It is expected that the manuscript of this monograph will be finished in November, 1908.

The Sauropoda in the Paris and British museums have recently been briefly studied by Professor Osborn, who has done some work on the Sauropoda monograph, with the assistance of W. K. Gregory.

David White was engaged during the larger part of the year in studying the kind, quality, and physical and chemical composition of coals of various epochs and areas, the conditions of deposition, the nature of the original material, and the present state of the organic matter. In the study of the microscopic structures of the coals he has had the aid of Reinhart Thiessen for most of the year. This work has been carried on at the request of the technologic branch, which has borne the expense of field work for two and a half months in the western areas and has paid one-half of Mr. White's salary and the entire salary of his assistant. A paper by Mr. White, discussing the relation of oxygen in coal to its calorific value, is now in preparation for publication.

F. H. Knowlton, besides performing field work, has studied and reported on more than 700 collections of fossil plants for the use of geologists in locating and correlating horizons in the Mesozoic and Tertiary, mainly in Alaska and the Rocky Mountain region. A little time was also devoted to preparing a report on the stratigraphy and paleontology of the Livingston formation in Montana.

Work on the bibliography and compendium of paleobotany has been carried on by Miss L. M. Schmidt, who for about two-thirds of the year has had the aid of Miss I. P. Evans. This work was done under the joint supervision of Messrs. White and Knowlton.

The preparation of the general geologic map of North America, which is being compiled in cooperation with the geological surveys of Canada and Mexico, has been continued by Bailey Willis. The basis of compilation is the map prepared in 1906 for the geological congress at the City of Mexico and printed at the expense of the Mexican Government, but it has been found desirable to revise a great deal of the material incorporated in that map in order to bring it up to date. The work includes also the preparation of a general description of the map and of the sources of the information it embodies, an account of the several geologic provinces of North America, and maps showing the geography of the continent at different geologic periods—all to be published in a professional paper of the Survey.

E. C. Harder made a reconnaissance examination of the principal manganese and manganiferous-ore deposits of the United States, giving special attention to their commercial aspect and preparing a report on them.

For many years N. H. Darton has been collecting data on underground temperatures. During the last year a number of very important observations were made and the preparation of a list of all deep underground temperatures determined in the United States was continued.

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under an appropriation of $80,000 for "continuation of the investigation of the mineral resources of Alaska," work of the following classes having been done: Reconnaissance and detailed geologic surveys; special investigations of mineral resources; reconnaissance and detailed topographic surveys; and investigations of water resources in reference to supply available for placer mining.

PERSONNEL.

The personnel of the division varies greatly during the year by transfers of technical employees to and from other divisions of the Survey and by the employment of temporary clerks, according to the demands of the work. Throughout the year 1 geologist in charge, 7 other geologists, 3 topographers, and 3 clerks have been employed. In addition 5 geologists were employed a part of the time on a per diem compensation. In May, 1908, 2 additional geologists, on annual salaries, were added to the force by transfer from other divisions. One additional topographer was employed up to the 1st of March, and 2 engineers were detailed to the division from the water-resources branch, giving about two-thirds of their time to the Alaskan work. In May, 1908, 2 additional engineers were temporarily detailed to the division.

During the season of 1907 the field force included also 1 topographic and 1 engineering field assistant and about 24 teamsters, cooks, etc. The temporary assistants in the field force for 1908 included 2 geologic and 2 topographic field assistants, with 25 laborers. Two temporary clerks have been employed in the office for three and six months. On June 30, 1908, the division included 1 geologist in charge, 9 other geologists on annual salaries and 3 geologists employed at a per diem compensation, 2 geologic field assistants, 3 topographers and 2 topographic field assistants, 4 engineers, 25 camp hands, and 3 clerks.

FIELD OPERATIONS IN SEASON OF 1907.

General outline.—Twelve parties engaged in Alaskan surveys and investigations during the field season of 1907. Six of these were carrying on geologic work, four were making topographic surveys, and two were engaged in stream gaging. The aggregate area covered by geologic reconnaissance surveys is 4,000 square miles; by detailed geologic surveys, 400 square miles; by topographic reconnaissance surveys, 6,125 square miles; and by detailed topographic surveys, 501 square miles. In addition, reconnaissance investigations of water resources were carried over an area of 1,000 square miles and studies were made in considerable detail over 400 square miles. Eleven of the 28 mining districts of Alaska in which developments are going on, including all but two of the most important, were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. The figures include the cost of both field and office work as well as of inspection.

Allotment to Alaskan surveys and investigations, 1907.

Continuation of general investigation of coal resources	$4, 700
Surveys and investigations in—	
Southeastern Alaska	5, 300
Copper River region	12, 000
Yukon region	41, 000
Seward Peninsula	17, 000
	80, 000

The following table shows the progress of Alaskan surveys since the beginning of systematic work in 1898 and the need for extending the map work:

Progress of surveys in Alaska, 1898–1907, in square miles.

Year.	Appropriation.	Geologic.		Topographic.		Hydrographic.	
		Reconnaissance.	Detailed.	Reconnaissance.	Detailed.	Reconnaissance.	Detailed.
1898	$46, 189. 60	9, 500		14, 912			
1899	25, 000. 00	6, 000		8, 688			
1900	25, 000. 00	10, 000		11, 152			
1901	35, 000. 00	12, 000		15, 664			
1902	60, 000. 00	17, 000		20, 304	336		
1903	60, 000. 00	13, 000	336	15, 008			
1904	60, 000. 00	6, 000		6, 480	480		
1905	80, 000. 00	8, 000	550	8, 176	948		
1906	80, 000. 00	9, 000	414	10, 768	40	1, 000	200
1907	80, 000. 00	4, 000	400	6, 125	501	1, 000	400
	551, 189. 60	94, 500	1, 700	117, 277	2, 305	2, 000	600
Percentage of total area of Alaska		16. 11+	. 3−	20	. 4	. 3+	. 1+

Administration.—As in previous years, the administration of the Alaskan division was in the hands of Alfred H. Brooks, who also devoted considerable time to various geologic problems connected with the investigation of the mineral wealth of the Territory. He also supervised personally the collection of statistics of the precious metals in the Territory and carried on some field work in southeastern Alaska and the Fairbanks district. The general supervision of the topographic work, as in previous years, was in charge of T. G. Gerdine until June, when he was succeeded by R. H. Sargent in this work. During the absence of the chief of the division E. M. Aten was left in charge of the office.

In pursuance of a general plan outlined two years ago, the study of the coal-bearing rocks of the Territory has been continued by W. W. Atwood and H. M. Eakin, who in 1907 visited the coal-bearing areas of southeastern Alaska and the Yukon and in connection with this work did some topographic and geologic mapping.

Southeastern Alaska.—The most important part of the geologic reconnaissance mapping in southeastern Alaska having been completed, detailed surveys were begun in 1907. A large part of the copper-producing district of Kasaan Peninsula, on Prince of Wales Island, including an area of 64 square miles, was mapped topographically by D. C. Witherspoon and J. W. Bagley in May, 1908, on a scale of 1:62500, and the same area was subsequently covered with geologic surveys made by C. W. Wright and Sidney Paige. Unfortunately, the weather conditions and other interruptions prevented the completion of these surveys, which are, however, now being continued.

Copper River region.—Though the geologic and topographic mapping in the Copper River basin was practically completed in 1902, the important industrial advancement in this field made it urgent that a reexamination of the copper-bearing belts should be undertaken, in order to collect the data bearing on the mineral wealth which had become available by the mining developments, and to embody it in a second edition of the report on this field. The Kotsina-Chitina copper belt, the most important, was chosen for investigation in 1907 and the work was carried to completion by F. H. Moffit and A. G. Maddren.

Yukon basin.—In view of the large gold production and important mining developments in the Fairbanks district, a detailed survey of this district was determined upon. This survey was made by T. G. Gerdine and R. H. Sargent, who mapped an area of 436 square miles for publication on a scale of 1 mile to the inch, with 25-foot contours.

In the Yukon region, where the water supply is an all-important feature of the placer-mining industry, the rainfall is slight and the stream flows are small. As there was urgent need for hydrographic investigation in this region, C. C. Covert, hydrographer, was detailed to begin work in the Fairbanks district, the largest producer of placer gold in the region. A single season's stream measurements can not be conclusive, yet the results are of considerable value in estimating the amount of water available for mining purposes.

As part of the plan to carry a topographic reconnaissance map over the most important parts of Alaska as soon as means permit, it was determined to continue the mapping in the Yukon-Tanana region during 1907. To this end D. C. Witherspoon and J. W. Bagley mapped an area of about 6,000 square miles lying between the international boundary, the Tanana, the Yukon, and the mouth of the Delta.

In the same general field geologic studies of the mineral resources were continued by L. M. Prindle, who completed the geologic mapping of the Fortymile quadrangle (submitted for publication) and also visited a number of other localities which promise to throw light on the geology and mineral resources.

Seward Peninsula.—As part of the plan to map geologically the important mining districts of Seward Peninsula in detail, the Solomon and Casadepaga districts were covered during the last season. This work was carried on by P. S. Smith, F. J. Katz, and George I. Findlay over an area of 400 square miles of exceedingly intricate geology, and important clues were obtained in regard to the structure and mineral resources of the peninsula. The complexity of the field, however, makes it necessary to supplement this work by further investigations before the report can be published. For this reason also the report on the geology of the Nome and Grand Central quadrangles has been withheld from publication, it being necessary to settle certain problems by further field investigations.

In accordance with the general plan made for the investigation of the water resources of Seward Peninsula two years ago, F. F. Henshaw, assisted by Raymond Richards, was detailed to continue stream measurements in this area. By this work additional data were obtained in the area previously examined. The work was also extended both northward into the Kougarok district, where important mining developments are going on, and eastward into the Solomon River region. It is expected that this preliminary study of the water resources of Seward Peninsula can be brought to a close during another field season.

FIELD OPERATIONS IN SEASON OF 1908.

Thirteen parties were dispatched to Alaska in March, April, May, and June, and another party will be sent early in July. One of these parties is carrying on detailed topographic surveys in southeastern Alaska. Another party is doing detailed geologic work in the same region, and still another is engaged in studying the copper-bearing region at the headwaters of White, Tanana, and Copper rivers. A detailed topographic survey of the eastern and best-developed portion of the Kotsina-Chitina copper belt was begun in April. The reconnaissance of the copper-bearing area of Prince William Sound is being completed. The coal-bearing rocks on Herendeen Bay are being investigated, and incidentally some reconnaissance surveys of this area are to be undertaken.

In the Yukon region a detailed geologic survey of the Fairbanks special area and an investigation of the water resources of the Fairbanks, Birch Creek, and Rampart regions have been begun. A party is also engaged in continuing the topographic reconnaissance survey of the Yukon-Tanana region, including a small area lying north of the Tanana between Fairbanks and the Delta, and a large area lying south of the Tanana between the Delta and the Nenana. A preliminary survey of the newly discovered Innoko placer district has been undertaken.

In Seward Peninsula two men are completing a reconnaissance of the water resources available for placer mining, and two parties are engaged in general studies of the stratigraphy and areal geology to obtain information needed in investigating the mineral resources.

OFFICE WORK.

It is gratifying to state that the office work bearing on the study of notes and specimens and also the preparation of manuscripts has been brought up to date, with the single exception of a report on the Mount McKinley region, by the geologist in charge.

In addition to the reports issued, there have been submitted for publication the following manuscripts: "The Ketchikan and Wrangell mining districts," by F. E. and C. W. Wright (Bulletin 347); "Physiography and glacial geology of the Yakutat Bay region, Alaska," by R. S. Tarr, with a chapter on the bed-rock geology, by R. S. Tarr and B. S. Butler; "Geology of the Seward Peninsula tin deposits," by Adolph Knopf (Bulletin 358); "Mineral resources of the Kotsina-Chitina copper belt," by F. H. Moffit and A. G. Maddren; and "Description of the Fortymile quadrangle, Yukon-Tanana region," by L. M. Prindle.

Two manuscripts bearing on the geology and mineral resources of Seward Peninsula, entitled "Geology of the Nome and Grand Central quadrangles," by F. H. Moffit, F. L. Hess, and P. S. Smith (nine-tenths completed), and "Geology of the Solomon and Casadepaga quadrangles," by P. S. Smith and F. J. Katz (three-fourths completed), are awaiting the solving of some general stratigraphic problems in Seward Peninsula. The report on "Copper deposits of the Kasaan Peninsula," by C. W. Wright, is about half done, but a month more of field work will be required before office work is undertaken. Mr. Atwood's summary report dealing with the Cretaceous and Tertiary coals of Alaska is about half done. The report entitled "An exploration in the Mount McKinley region," by Alfred H. Brooks, is three-fourths completed.

GEOLOGIC RESULTS.

It is difficult to summarize the geologic results of one year's work, as these may embody much previous preparation and study and are usually attained by gradual evolution. Worthy of record, however, is the additional knowledge gained on the genesis and distribution of the copper deposits of southeastern Alaska by C. W. Wright, and on the tin and other metal-bearing lodes of Seward Peninsula by Adolph Knopf. L. M. Prindle's studies in the Yukon-Tanana region point to the conclusion that large batholithic masses of intrusive rocks are there mantled by a comparatively thin shell of metamorphic sediments and that the gold deposits are closely connected with the intrusions. W. W. Atwood's investigations indicate that there was more than one extensive period of base-leveling in the Yukon basin. In Seward Peninsula Messrs. Smith and Katz have obtained evidence of exceedingly intricate folding of the metamorphic sediments of the Nome group. The Chitistone limestone in the Copper River region, long believed to be Carboniferous, has been proved to be Triassic by fossils collected by Messrs. Moffit and Maddren and determined by T. W. Stanton. This adds at least 4,000 feet of strata, and probably double that amount, to the Triassic section of central Alaska.

The report on the geology and mineral resources of the Controller Bay region, by G. C. Martin (Bulletin 337), describes the geography and the bed-rock, glacial, and economic geology of this region, which lies on the Pacific coast of Alaska between meridians 143° 45′ and 144° 40′. Most of the bed-rock formations fall into two groups, one of which is known to be Tertiary (Miocene?), and the other is probably Tertiary. There is also a small area of metamorphic rocks of unknown age. The sediments are closely folded and profoundly faulted. Igneous rocks are represented solely by a few dikes. The mineral resources include some oil seepages, with two wells that have made a small production. Of far greater importance are the coal beds. These coals are anthracite and semibituminous and include some coking coals. They are known to underlie an area of 56.4 square miles, and the field probably extends to the northeast, beyond the area mapped.

DIVISION OF MINERAL RESOURCES.

The work of the division of mineral resources consisted in the preparation of reports on the mineral resources of the United States for 1906 and 1907. The report for 1906 was completed, published, and distributed, and the report for 1907 was prepared in part, seventeen chapters of it having been completed before the close of the fiscal year 1907–8 and transmitted for publication separately in advance of the volume. The chapters on aluminum and bauxite, cement, asbestos, monazite and zircon, and phosphate rock were printed and distributed before June 30, and the manuscript for the reports on asphalt and bituminous rock, barytes, anthracite coal, fluorspar and cryolite, fuller's earth, gypsum, manganese ores, mica, mineral paints, salt and bromine, tin, and slate was submitted for publication. The production statistics for many other minerals were announced to the press for publication in advance of the full report.

Waldemar Lindgren, geologist in charge of economic geology of metalliferous ores (except iron), has given about one-half of his time to the administrative work on the same subjects for this division. During July and August, 1907, Mr. Lindgren spent some time in the Denver office, having been detained in that city as witness in the suit instituted by the postal authorities against the Lost Bullion Mining Company of New Mexico. During March and April Mr. Lindgren made a tour of inspection covering the three suboffices, San Francisco, Salt Lake City, and Denver.

Congress having failed to make specific appropriations for continuing the investigation of the black sands of the Pacific coast and other portions of the United States, this investigation was discontinued July 1, 1907.

A considerable part of the time of the experts employed in this division is consumed in answering technical inquiries and making visual examinations of mineral specimens that are submitted by numerous persons for determination. Inquiries for information as to the character of ores are answered as promptly as possible, and such information is given freely where a chemical analysis or assay is not required.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the physical laboratory George F. Becker continued his investigations on geophysical problems, with particular reference to their application to geology. C. E. Van Orstrand has remained in immediate charge of the work on elasticity. In addition to theoretical investigations and the reduction of observations made at the Washington Monument, systematic observations have been made on the elastic after-effect of steel tapes maintained at a constant temperature. The problem presents many difficulties from either a theoretical or an experimental standpoint; but the possibility of its application to a precise discussion of the stress-strain relation, the variation of electric resistance, the condition of isostasy which probably exists in the crust of the earth, the internal resistances of solids, etc., would seem to justify a general investigation of high precision. A few experiments on the diffusivity of solid metals are being conducted, partly with the hope of throwing some light on the mechanism of the elastic after-effect, but chiefly for the purpose of investigating a very interesting property of matter which has hitherto received but little attention from scientific men. The following publications indicate the scope of these investigations:

Becker, G. F., Current theories of slaty cleavage. (Am. Jour. Sci., July, 1907.)

Becker, G. F., and Van Orstrand, C. E., Tables of hyperbolic functions. (Now in course of publication by the Smithsonian Institution.)

Van Orstrand, C. E., Inverse interpolation by means of a reversed series. (Philos. Mag., May, 1908.)

Becker, G. F., Age of a cooling globe in which the initial temperature increases directly as the distance from the surface. (Science, February 7, 1908.)

Becker, G. F., Relations of radioactivity to geology and cosmogony. (Bull. Geol. Soc. America.)

In the chemical laboratory during the year 116 quantitative analyses were reported, and also 826 qualitative determinations, chiefly of minerals sent for examination by persons not connected with the Survey. F. W. Clarke completed and published during the year his bulletin (No. 330) entitled "The data of geochemistry." He also published a paper on the composition of two marine sediments—the average "red clay" and the intermediate terrigenous clay. W. F. Hillebrand published an important paper on vanadium minerals from Peru, and a joint paper with W. T. Schaller on the mercury minerals of Texas. He also made a considerable number of analyses of lead bullets, furnishing data for use of the United States Senate committee in the Brownsville investigation. He conducted and completed an investigation on the determination of ferrous iron and water in rock analyses. E. C. Sullivan continued his work on the chemistry of ore deposition until April 1, when he severed his connection with the Survey, having accepted an invitation to engage in work for a private firm. George Steiger, whose time was largely occupied with routine work, completed and published the results of two investigations on analytical methods, one on a new form of colorimeter and the other on the estimation of small quantities of fluorine. He also did some work on the dehydration of gypsum and on the precipitation of zirconium as phosphate. W. T. Schaller, in addition to his necessary routine work, including a large number of mineral determinations, published several papers on mineralogical subjects. A paper by Messrs. Hillebrand and Schaller on the mercury minerals from Terlingua, Tex., is nearly ready for publication as a bulletin of the Survey.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch remained the same as at the close of the last fiscal year until January 18, 1908, when R. B. Marshall was appointed chief geographer and T. G. Gerdine succeeded Mr. Marshall as geographer in charge of the Pacific division. The organization is as follows:

Atlantic division, Frank Sutton, geographer in charge.

Central division, W. H. Herron, geographer in charge.

Rocky Mountain division, E. C. Barnard, geographer in charge.

Pacific division, T. G. Gerdine, geographer in charge.

Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and F. E. Matthes, topographers.

E. M. Douglas, geographer in charge of office prior to the appointment of the chief geographer, retains immediate supervision of the computing and instrument sections, and is in general charge of the office administration of the topographic branch in the absence of the chief geographer. During April, May, and June Mr. Douglas was in charge of the survey of the boundary of the Luquillo National Forest in Porto Rico.

Henry Gannett, geographer, was absent on leave during the whole year while assistant director of the Cuban census.

PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 16 junior topographers, 4 assistant topographers, and 1 draftsman. It was reduced by death, transfers, and resignations amounting to 12. With these changes the technical force now includes a chief geographer, 9 geographers, 40 topographers, 38 assistant topographers, 4 topographic aids, 20 junior topographers, and 4 draftsmen. Four of the topographers and 1 geographer are on leave without pay. In addition to the above regular force 167 technical field assistants were employed during the whole or a part of the field season.

SUMMARY OF RESULTS.

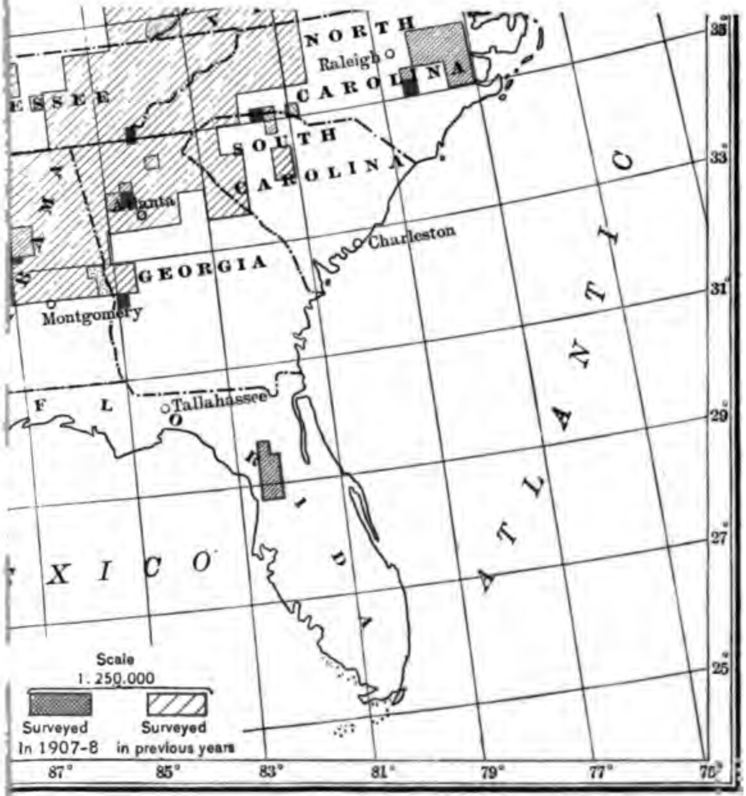
The condition of topographic surveys to July 1, 1908, distinguished as to scale, etc., is shown on Pl. II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total area mapped was 25,658 square miles, making the total area surveyed to date in the United States 1,051,126 square miles, or about 35 per cent. In addition, 6,979 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 32,637 square miles.

Triangulation and primary-traverse stations to the number of 504 were occupied, located, and marked and 19 were intersected, and 3,468 miles of primary traverse were run. In the course of this work 35,325 square miles were covered by primary control.

In connection with these surveys 7,543 linear miles of primary levels and 843 miles of precise levels were run, making the total amount of primary and precise spirit leveling done since the authorization of this work by Congress, in 1896, 212,149 miles.

The area covered by topographic surveys in Alaska during the fiscal year 1907-8, as reported in detail on pages 40-43, was about 6,626 square miles, 501 of which were mapped for publication on the scale of 1:62,500 and 6,125 for publication on the scale of 1:250,000.



APHIC SURVEYS

The results of primary triangulation and primary traverse in all States in which field work was in progress were summarized and prepared for publication as a bulletin.

Present condition of topographic surveys of the United States and new areas surveyed in 1907–8.

State or Territory.	New area surveyed in 1907–8.	Total area surveyed to July 1, 1908.	Percentage of total area of State surveyed to July 1, 1908.
	Sq. miles.	*Sq. miles.*	
Alabama	....	18,283	35
Arizona	250	62,962	55
Arkansas	....	20,469	38
California	2,998	82,379	52
Colorado	1,130	38,896	87
Connecticut	....	4,965	100
Delaware	....	1,008	43
District of Columbia	....	70	100
Florida	....	1,821	3
Georgia	232	17,087	29
Idaho	162	15,358	18
Illinois	771	8,171	14
Indiana	160	2,618	7
Iowa	197	10,092	18
Kansas	....	64,159	78
Kentucky	1,330	15,845	39
Louisiana	....	7,923	16
Maine	380	7,185	22
Maryland	....	10,294	84
Massachusetts	....	8,266	100
Michigan	491	4,244	7
Minnesota	211	3,087	4
Mississippi	97	1,003	2
Missouri	229	34,246	49
Montana	1,788	48,977	33
Nebraska	....	25,974	34
Nevada	3,739	44,221	40
New Hampshire	216	3,376	36
New Jersey	....	8,224	100
New Mexico	1,255	29,990	24
New York	599	38,808	79
North Carolina	344	17,418	33
North Dakota	144	8,919	13
Ohio	3,070	23,067	56
Oklahoma	1,168	37,663	54
Oregon	1,053	17,333	18
Pennsylvania	1,421	21,029	47
Rhode Island	....	1,248	100
South Carolina	144	5,640	18
South Dakota	....	17,956	23
Tennessee	242	20,345	48
Texas	469	66,314	25
Utah	....	63,320	75
Vermont	....	3,537	37
Virginia	151	29,960	70
Washington	170	18,398	27
West Virginia	....	24,120	99.8
Wisconsin	176	11,373	20
Wyoming	871	23,465	24
	25,658	1,051,126	....

ATLANTIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Alabama, Georgia, Kentucky, Maine, Maryland, Mississippi, New Hampshire, New York, North Carolina, South Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. This work comprised the survey of 33 quadrangles and the resurvey or revision of 11 quadrangles and 1 special area. In addition, 18 quadrangles were partly surveyed and 5 quadrangles partly resurveyed. The total new area mapped was 8,226 square miles—8,129 square miles for publication on the scale of 1:62,500, and 97 square miles for publication on the scale of 1:31,680. The area resurveyed was 3,046 square miles—248 for publication on the scale of 1:125,000, 2,710 for publication on the scale of 1:62,500, and 88 for publication on the scale of 1:36,000. In connection with this work 2,993 miles of primary levels and 304 miles of precise levels were run and 898 permanent bench marks were established.

Primary triangulation, primary traverse, and precise leveling were carried on at various times by eight parties. This work was distributed over portions of Alabama, Kentucky, Maine, Maryland, Mississippi, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. The total area covered by this primary control was about 8,550 square miles, of which 6,300 square miles were controlled by primary traverse. The result of this work was to make control available in forty-one 15-minute quadrangles.

Topographic surveys in Atlantic division from June 1, 1907, to July 1, 1908.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.	
		1:125,000.	1:62,500.			Distance run.	Bench marks.
		Resurvey.	New.	Resurvey.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Alabama	50	248		145	393	31	31
Georgia	20-50		232	247	[a] 501	96	28
Kentucky	20		1,330		1,330	483	86
Maine	20		380		380	82	23
Maryland	20			684	684	101	26
Mississippi					[b] 97	246	65
New Hampshire	20		216		216		
New York	20		599		599	231	57
North Carolina	20		344		[a] 349		
Ohio	20		3,070		3,070	965	298
Pennsylvania	20		1,421	58	1,479	456	117
South Carolina	20		144		144		
Tennessee	20		242		[a] 303	72	14
Virginia	20-50		151	72	223	53	10
West Virginia	50			1,504	1,504	481	143
		248	8,129	2,710	11,272	3,297	898

[a] 88 square miles of resurvey, 5 in North Carolina, 22 in Georgia, 61 in Tennessee, for publication on the scale of 1:36,000.

[b] 97 square miles in Mississippi for publication on scale of 1:31,680.

DETAILS OF WORK BY STATES.

Alabama.—The resurvey of the Opelika quadrangle, in Chambers and Lee counties, was completed by R. W. Berry, 248 square miles being mapped for publication on the scale of 1:125,000, with a contour interval of 50 feet. The resurvey of the Montevallo quadrangle, in Shelby, Chilton, and Bibb counties, was commenced by Mr. Berry, 145 square miles being completed, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these and adjoining areas 31 miles of primary levels were run and 31 permanent bench marks were established by A. K. Gilman and J. B. Metcalf. The control of the Seale quadrangle, in Lee and Russell counties, was completed by F. J. McMaugh, who ran 38 miles of primary traverse.

Georgia.—The resurvey of the Acworth quadrangle, in Cherokee, Bartow, and Cobb counties, and the survey of the Columbus quadrangle, in Chattahoochee and Muscogee counties, were completed by Duncan Hannegan. The total area resurveyed was 247 square miles and the new area surveyed was 232 square miles, all for publication on the scale of 1:62,500, with contour intervals of 20 and 50 feet. For the control of the Columbus quadrangle 96 miles of primary levels were run and 28 permanent bench marks were established by J. B. Metcalf.

Kentucky.—For the continuation of cooperative topographic surveys the state geologist allotted $8,000 and the federal Survey allotted a like sum. The Providence, Earlington, Madisonville, Central City, Hartford, and Whitesville quadrangles, in Webster, Hopkins, Caldwell, Crittenden, Daviess, Ohio, Hancock, McLean, Muhlenberg, and Butler counties, were completed by Van. H. Manning, A. O. Burkland, C. C. Gardner, R. L. Harrison, T. H. Moncure, and R. W. Berry. The total area surveyed was 1,330 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these quadrangles 408 miles of primary spirit levels were run and 61 permanent bench marks were established by H. W. Peabody and G. W. Crane, and in addition 178 miles of primary traverse were run and 10 stations established by C. B. Kendall. A line of precise levels 75 miles in length was run by W. H. Monahan from Center along the Illinois Central Railroad to Cerulean Springs, crossing Caldwell, Crittenden, Elmore, and Trigg counties, and furnishing control for the Eddyville, Marion, Morganfield, Princeton, Providence, and Shawneetown quadrangles. In connection with this line 25 permanent bench marks were established.

Maine.—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted $2,500 and the United States Geological Survey allotted a like sum. The survey of the Eastport quadrangle, in Washington County, and the Poland quadrangle, in Androscoggin, Oxford, and Cumberland counties, was completed, and that of the Ellsworth quadrangle, in Hancock County, was commenced. This work was done by Hersey Munroe, R. Purington, and F. E. Matthes, the total area surveyed being 380 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Eastport quadrangle 82 miles of primary levels were run and 23 permanent bench marks were established by H. M. Gilman, jr. The Ellsworth quadrangle, in Hancock County, was controlled by S. S. Gannett by means of triangulation, 5 stations being occupied and 2 points located by intersections.

Maryland.—For the continuation of cooperative topographic surveys in Maryland the state geologist allotted $5,000 and the federal Survey allotted $4,000. The resurvey of the Ijamsville and Mount Airy quadrangles and the Maryland portion of the Seneca quadrangle was completed, and that of the Middletown and Taneytown quadrangles was commenced. The total area resurveyed was 684 square miles, in Montgomery, Frederick, Carroll, Howard, and Jefferson counties, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by W. Carvel Hall, J. H. Wheat, Fred Graff, E. W. McCrary, J. S. B. Daingerfield, J. D. Forster, L. C. Fletcher, and S. P. Floore. For the control of these and adjacent areas 101 miles of primary levels were run and 26 permanent bench marks were established by W. R. Winstead and J. E. McCorkle. The Emmitsburg and Taneytown quadrangles, in Frederick, Carroll, and Montgomery counties, and the Seneca quadrangle, in Montgomery County, Md., and Fairfax County, Va., were controlled by 119 miles of primary traverse run and 9 stations established by F. J. McMaugh.

Mississippi.—For cooperative topographic surveys in Mississippi the state Geological Survey and the United States Geological Survey each allotted $1,600. An irregular area of 323 square miles in the vicinity of Clarksdale, in Coahoma, Bolivar, Quitman, Tallahatchie, Panola, and Tunica counties, was controlled, under the direction of C. D. S. Clarkson, by 80 miles of primary levels run by J. E. McCorkle and W. W. Boone, who established 18 permanent bench marks; and by 158 miles of primary traverse and 15 stations established by F. J. McMaugh and C. A. Clunet.

On May 11 a tentative agreement was entered into with the governor of the State and the president of the Tallahatchie drainage commission, which empowered the federal Survey to undertake the mapping of the Tallahatchie drainage district. On June 15 a final agreement was made which provided that the Geological Survey should expend $9,000 for this work and the Tallahatchie drainage commission $27,000, more or less, to complete the survey of the district. Work was commenced by Van. H. Manning, E. P. Davis, R. L. Harrison, C. C. Gardner, and J. R. McMillen on the Belen, Coahoma, and Evansville quadrangles, in Coahoma, Quitman, and Tunica counties, the survey of 97 square miles being completed, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of this district 101 miles of primary and 65 miles of precise levels were run by L. L. Lee, C. C. Gardner, and W. H. Monahan, in connection with which 47 permanent bench marks were established and 172 miles of primary traverse were run and 58 stations established by F. J. McMaugh and C. A. Clunet.

Alabama-Mississippi-Tennessee.—The Iuka quadrangle, in Colbert and Lauderdale counties, Ala., Tishomingo County, Miss., and Hardin County, Tenn., was controlled by 84 miles of primary traverse run by F. J. McMaugh.

New Hampshire.—The survey of the Lake Winnipesaukee quadrangle, in Belknap and Carroll counties, was completed by J. I. Gayetty, for publication on the scale of 1:62,500, with a contour interval of 20 feet, the area mapped being 216 square miles.

New York.—The state engineer and surveyor allotted $8,000 for the continuation of the cooperative topographic survey of the State, and the federal Survey allotted a like amount for the same purpose. The work on the Cooperstown quadrangle, in Otsego County, and the Stony Creek quadrangle, in Warren, Hamilton, and Saratoga counties, was completed; that on the Delhi quadrangle, in Otsego and Delaware counties; the Neversink quadrangle, in Sullivan and Ulster counties; and the Bath quadrangle, in Steuben County, was partly completed. This work was done by C. E. Cooke, W. H. S. Morey, Fred Graff, jr., W. M. Beaman, J. I. Gayetty, L. C. Fletcher, J. M. Whitman, and S. P. Floore, the area surveyed being 599 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjoining areas 231 miles of primary levels were run and 57 permanent bench marks were established by C. H. Semper.

North Carolina.—The survey of the Great Coharie quadrangle, in Sampson County, was completed by Albert Pike, the area mapped being 244 square miles.

North Carolina-South Carolina.—The survey of the Gaffney quadrangle, in Cleveland County, N. C., and Cherokee County, S. C., was completed by W. L. Miller and L. L. Lee. The area surveyed was 244 square miles, 100 of which are in North Carolina, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Ohio.—The governor of Ohio allotted $19,000 for the continuation of the cooperative topographic survey of the State, and a like sum was set apart for the same purpose by the United States Geological Survey. The survey of the Ottawa, McClure, Napoleon, Continental, and Defiance quadrangles, in Defiance, Williams, Lucas, Paulding, Putnam, Henry, Wood, and Fulton counties; the Newark, Thurston, Thornville, Logan, and Lancaster quadrangles, in Licking, Knox, Muskingum, Pickaway, Fairfield, Perry, and Hocking counties; and the Alliance, Lisbon, and Columbiana quadrangles, in Stark, Columbiana, and Mahoning counties, was completed, and that of the Frazeysburg, Conesville, Zanesville, New Lexington, and Granville quadrangles, in Coshocton, Morgan, Perry, Hocking, Athens, Muskingum, and Licking counties, was commenced. This work was done by J. H. Jennings, R. C. McKinney, W. H. S. Morey, R. D. Cummin, W. H. Monahan, J. S. B. Daingerfield, C. W. Goodlove, J. M. Whitman, I. M. Flocker, J. A. Duck, and W. H. Lovell, the area surveyed being 3,070 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 965 miles of primary levels were run and 298 permanent bench marks were established by C. H. Semper, R. C. Seitz, C. H. Burns, W. H. Monahan, I. M. Flocker, and E. C. Bibbee. The Coshocton, Brinkhaven, Caldwell, McConnellsville, New Lexington, Millersburg, and Plimpton quadrangles, in Holmes, Wayne, Ashland, Coshocton, Knox, Washington, Morgan, and Perry counties, were controlled by 299 miles of primary traverse run and 28 stations established by C. B. Kendall.

Pennsylvania.—The Geologic and Topographic Survey Commission of Pennsylvania allotted $11,500 for the continuance of cooperative topographic surveys of the State, and the United States Geological Survey allotted a like sum for the same purpose. The survey of the Shenango quadrangle, in Mercer and Crawford counties; the Smicksburg quadrangle, in Jefferson, Armstrong, and Indiana counties; the Foxburg quadrangle, in Venango, Clarion, Butler, and Armstrong counties; the Gettysburg quadrangle, in Adams and York counties, and the Freeport quadrangle, in Armstrong, Butler, Allegheny, and Westmoreland counties, was completed; and that of the York quadrangle, in York County; the Zelionople quadrangle, in Butler and Lawrence counties; the Bedford quadrangle, in Bedford, Somerset, and Cambria counties; the Fairfield quadrangle, in Adams County, and the New Kensington quadrangle, in Butler and Allegheny counties, was commenced. This work was done by J. H. Jennings, C. W. Goodlove, Hersey Munroe, J. M. Whitman, W. O. Tufts, R. H. Reineck, L. C. Fletcher, J. H. Wheat, J. S. B. Daingerfield, A. O. Burkland, J. D. Forster, and R. W. Berry, the total area surveyed being 1,421 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition, the work on 58 square miles of the Sewickley quadrangle was revised. For the control of these and adjoining areas 456 miles of primary levels were run and 117 permanent bench marks were established by C. H. Semper, H. D. Hilton, and C. H. Burns. The Bellefonte and Philipsburg quadrangles, in Center and Clearfield counties; the McCall Ferry and Quarryville quadrangles, in Lancaster and York counties; and the Franklin, Hilliards, Mercer, and Stoneboro quadrangles, in Butler, Crawford, Mercer, Lawrence, and Venango counties, were controlled by 411 miles of primary traverse run and 30 stations established by F. J. McMaugh and C. B. Kendall. The Berlin, Meyersdale, Confluence, Hyndman, and Somerset quadrangles, in Somerset, Fayette, Bedford, and Westmoreland counties, were partly controlled by triangulation by G. T. Hawkins, who occupied 9 stations.

Tennessee.—The survey of the Franklin quadrangle, comprising an area of 242 square miles in Williamson and Maury counties, was completed by Oscar Jones, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 19 miles of primary levels were run and four permanent bench marks were established. Mr. Jones also ran 93 miles of primary traverse and established 4 stations for the control of the Hollow Springs quadrangle, in Coffee, Rutherford, Cannon, and Bedford counties.

Tennessee-North Carolina-Georgia.—The mapping of the Ducktown special area was completed by Oscar Jones, the area covered being 88 square miles, 5 of which are in Cherokee County, N. C., 22 in Fanning County, Ga., and 61 in Polk County, Tenn., for publication on the scale of 1:36,000, with a contour interval of 20 feet. For the control of this area Mr. Jones located 4 new stations by means of triangulation, and J. G. Martin and W. H. Gray ran 53 miles of primary levels, in connection with which 10 permanent bench marks were established.

Virginia.—The survey of the Eagle Rock quadrangle, in Botetourt, Alleghany, and Craig counties, was commenced by Albert Pike and T. H. Moncure; and the resurvey of the Virginia portion of the Seneca quadrangle, in Fairfax and Loudoun counties, was completed by W. Carvel Hall and J. D. Forster. The new area mapped was 151 square miles and the area resurveyed was 72 square miles—all for publication on the scale of 1:62,500, with contour intervals of 20 and 50 feet. For the control of these and adjacent areas 42 miles of primary levels were run and 10 permanent bench marks were established by R. S. Deemer and W. B. Winstead.

Virginia-West Virginia.—A line of precise levels was extended by C. H. Semper from the vicinity of Covington, Va., to Charleston, W. Va., 11 miles being in Virginia and 153 miles in West Virginia. The line extended along the Chesapeake and Ohio and the Kanawha and Michigan railways, passing across the Lewisburg, Hinton, Raleigh, Kanawha Falls, and Charleston quadrangles, in Alleghany County, Va., and Greenbrier, Summers, Fayette, and Kanawha counties, W. Va. The work in West Virginia was done in cooperation with the State.

West Virginia.—For the continuation of cooperative topographic surveys in West Virginia the state geologist allotted $12,000 and the federal Survey allotted an equal sum. The resurvey resulted in the completion of the work on the Elkins quadrangle, in Randolph and Barbour counties, and the Wayne, Midkiff, St. Albans, Charleston, and Clendennin quadrangles, in Wayne, Lincoln, Kanawha, Putnam, Clay, and Logan counties, and the commencement of the work on the Clay quadrangle, in Clay and Nicholas counties. This work was done by E. I. Ireland, J. R. Eakin, S. P. Floore, T. F. Slaughter, J. I. Gayetty, and P. W. McMillen, the area surveyed being 1,504 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these and adjoining quadrangles, 328 miles of primary levels were run and 86 permanent bench marks were established by C. H. Semper, O. N. Meredith, C. K. Alexander, and E. S. Dawson. The Clendennin and Clay quadrangles, in Clay, Kanawha, and Nicholas counties, and the Horton and Elkins quadrangles, in Randolph and Tucker counties, were controlled by D. H. Baldwin, who located 12 new stations by triangulation. The Montgomery, Winifrede, and Fayetteville quadrangles, in Boone, Fayette, Kanawha, Clay, and Nicholas counties, were partly controlled by R. H. Chapman, assisted by P. W. McMillen, who occupied 3 stations.

Porto Rico.—In compliance with a request from the Forest Service for an immediate survey of the boundary of the Luquillo National Forest, the work was commenced in March and completed early in June by E. M. Douglas, geographer, in charge of party, and C. L. Nelson, assistant topographer, 40.2 miles of line having been surveyed and marked by 98 concrete, stone, or wooden posts. In order to locate the corners of the reserve two United States Coast and Geodetic Survey triangulation stations were occupied and four new stations were selected, marked, and occupied. In addition to an accurate contour sketch of a narrow strip along the entire boundary, a reconnaissance sketch of 54 square miles of the reserve was made by Mr. Nelson.

OFFICE WORK.

The drafting of the following sheets was completed: Opelika, Ala.; Acworth and Columbus, Ga.; Providence, Hartford, Earlington, Madisonville, Central City, and Whitesville, Ky.; Eastport and Poland, Me.; Seneca, Ijamsville, and Mount Airy, Md.; Lake Winnepesaukee, N. H.; Cooperstown, N. Y.; Great Coharie and Gold Hill, N. C.; Gaffney, N. C.-S. C.; Newark, Logan, Lancaster, Columbiana, Lisbon, Alliance, Thurston, Napoleon, Continental, McClure, Ottawa, Thornville, and Defiance, Ohio; Gettysburg, Shenango, Foxburg, Freeport, and Smicksburg, Pa.; Franklin and Ducktown special, Tennessee; Charleston, St. Albans, Clendennin, Elkins, Wayne, and Midkiff, W. Va.

Progress in the drafting of additional sheets was made as follows: Middletown, Md., 5 per cent; Stoney Creek, N. Y., 38 per cent; Eagle Rock, Va., 60 per cent.

In the triangulation and computing section the following computations were made:

For the control of the Seale (Ala.) quadrangle, 262 latitudes and departures and 35 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Madisonville, Earlington, Central City, and Hartford (Ky.) quadrangles, 1,622 latitudes and departures and 182 geographic positions were computed. For the control of the Princeton, Dawson Springs, Greenville, and White Plains (Ky.) quadrangles, 1,317 latitudes and departures and 159 geographic positions were computed. Level circuits were adjusted in the same area.

The geodetic positions of six triangulation points for the control of the Ellsworth (Me.) quadrangle were computed. Level circuits in the Eastport, Poland, Lewiston, and Cutler (Me.) quadrangles were adjusted.

For the control of the Emmitsburg, Taneytown, and Seneca quadrangles (Md.-Va.), 853 latitudes and departures and 123 geographic positions were computed. Level circuits in these areas and also in the Middletown (Md.) quadrangle were adjusted.

For the control of the Friars Point and Clarksdale (Miss.) quadrangles, 495 latitudes and departures and 84 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Iuka (Miss.-Ala.-Tenn.) quadrangle, 1,071 latitudes and departures and 77 geographic positions were computed.

Level circuits were adjusted in the Bath, Delhi, and Monticello (N. Y.) quadrangles.

For the control of the Millersburg, Plimpton, Coshocton, Brinkhaven, Caldwell, McLean, and New Lexington (Ohio) quadrangles, 2,565 latitudes and departures and 320 geographic positions were computed. Level circuits throughout Ohio were readjusted on the basis of the 1907 adjustment of the precise-level net as made by the Coast and Geodetic Survey.

For the control of the Bellefonte, McCall Ferry, and Quarryville (Pa.) quadrangles, 2,274 latitudes and departures and 242 geographic positions were computed. Level circuits in the Butler, Smicksburg, Bedford, Brookville, and York (Pa.) quadrangles were adjusted.

For the control of the Ducktown (Tenn.-N. C.-Ga.) special quadrangle the final geodetic positions of four triangulation points were computed and level circuits in the same vicinity were adjusted.

The office computation of the precise-level line extending from Covington, Va., to Charleston, W. Va., was made.

The geodetic positions of 12 triangulation stations, located for the control of the Clendennin, Clay, Horton, and Elkins (W. Va.) quadrangles, were computed. Level circuits on the Midkiff, Wayne, Clendennin, and Elkins (W. Va.) quadrangles were adjusted.

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic surveying was carried on in Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Oklahoma, Texas, and Wisconsin. The survey of 14 quadrangles and the resurvey of 2 quadrangles were completed. In addition, 13 quadrangles were partly surveyed and the resurvey of one quadrangle and one special area was partly completed. The total new area mapped was 3,872 square miles—3,002 for publication on the scale of 1:62.500 and 870 for publication on the sale of 1:125,000. The area resurveyed was 843 square miles—625 for publication on the scale of 1:62,500 and 218 for publication on the scale of 1:24,000. In connection with this work, 2,049 miles of primary levels and 331 miles of precise levels were run and 564 permanent bench marks were established.

Primary traverse and precise leveling were carried on at various times by seven parties, the work being distributed over portions of Arkansas, Illinois, Indiana, Iowa, Michigan, Missouri, Oklahoma, Wisconsin, and Texas. The total area covered by primary traverse was 6.075 square miles, furnishing control in one 30-minute and thirty-one 15-minute quadrangles.

Topographic surveys in central division from June 1, 1907, to July 1, 1908.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.	
		1:125,000.	1:62,500.			Distance run.	Bench marks.
		New.	New.	Resurvey.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles*	
Arkansas						63	16
Illinois	20		771		771	694	141
Indiana	20		160		160	65	21
Iowa	20		197		197	99	20
Kansas	20				[a]89	3	
Michigan	20		491		491	258	77
Minnesota	20		211		211	584	94
Missouri	20		229	407	[a]765	163	31
Oklahoma	20–50	401	767		1,168	241	95
Texas	20	469			469	217	61
Wisconsin	20		176	218	394	43	8
		870	3,002	625	4,715	2,380	564

[a] 218 square miles of resurvey (89 in Kansas and 129 in Missouri) for publication on the scale of 1 : 24,000.

DETAILS OF WORK BY STATES.

Arkansas.—For the control of the De Queen quadrangle, in Sevier, Polk, and Howard counties, W. A. Gelbach ran 63 miles of primary levels and established 16 permanent bench marks, and J. R. Ellis ran 119 miles of primary traverse and occupied 11 stations.

Illinois.—The governor of Illinois allotted $8,000 for the continuation of cooperative topographic surveys in the State, and the United States Geological Survey allotted a like sum for the same purpose. The survey of the Tallula quadrangle, in Morgan, Sangamon, Cass, and Menard counties; the Herrin quadrangle, in Jackson, Perry, Franklin, and Williamson counties; and the West Frankfort quadrangle, in Franklin and Williamson counties, was completed; and that of the Carlyle, New Athens, and Okawville quadrangles, in St. Clair, Washington, Clinton, and Bond counties; the Hardinville quadrangle, in Jasper, Crawford, Richland, and Lawrence counties; and the Vandalia quadrangle, in Fayette County, was commenced. This work was done by W. J. Lloyd, E. W. McCrary, J. F. McBeth, H. L. McDonald, Lee Morrison, and J. E. Tichenor, the total area surveyed being 771 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 662 miles of primary levels were run and 129 permanent bench marks were established by W. J. Lloyd, W. A. Gelbach, and Henry Bucher, and 236 miles of primary traverse were run and 22 stations established by J. R. Ellis. The Lasalle and Hennepin quadrangles, in Lasalle, Bureau, and Putnam counties, were controlled by 104 miles of primary traverse run and 5 stations established by C. B. Kendall. A line of precise levels 32 miles in length, extending from the vicinity of Terre Haute, Ind., to Oakland, Ill., through the Paris and Kansas quadrangles, in Edgar County, was run by C. H. Semper, and in connection with this work 12 permanent bench marks were established.

Indiana.—The survey of the Bloomington quadrangle, in Munroe, Owen, and Greene counties, was commenced by W. H. Griffin and C. L. Sadler, the area covered being 140 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. A line of precise levels 57 miles in length was extended by C. H. Semper through the Bloomfield, Jasonville, and Saline City quadrangles, in Clay and Vigo counties, and in connection with this work 19 permanent bench marks were established. Mr. Sadler also ran 8 miles of primary levels and established two permanent bench marks for the control of the same general area.

Iowa.—The state geologist allotted $1,750 for cooperative topographic surveys in Iowa and the federal Survey allotted a like sum for the same purpose. The survey of the Milo quadrangle, in Warren and Marion counties, was commenced by J. G. Staack and A. T. Fowler, the area covered being 197 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area 76 miles of primary traverse were run and 7 stations established by J. R. Ellis, and 99 miles of primary levels were run and 20 permanent bench marks were established by W. A.

Gelbach. For the control of the Knoxville and Pella quadrangles, in Marion and Mahaska counties, Mr. Ellis ran 72 miles of primary traverse and established 7 stations.

Kansas-Missouri.—The resurvey of an area already covered by reconnaissance maps—the Fort Leavenworth special quadrangle, in Leavenworth County, Kans., and Platte County, Mo.—was commenced by Glenn S. Smith, Arthur Stiles, and J. G. Staack, the area completely surveyed being 218 square miles, 129 of which are in Missouri, for publication on the scale of 1:24,000, with a contour interval of 20 feet. In connection with this work 6 miles of primary levels, 3 being in Missouri, were run and 1 permanent bench mark was established by A. J. Ogle.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the state geologist and the United States Geological Survey each allotted $3,000. The survey of the Howell and Milford quadrangles was completed and that of the Durand and Fowlerville quadrangles was commenced by A. M. Walker and C. D. S. Clarkson, the total area surveyed being 491 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This area lies in Livingston, Oakland, Shiawassee, Genesee, and Ingham counties. For the control of these quadrangles and adjacent areas 258 miles of primary levels were run and 77 permanent bench marks were established by C. B. Kendall and Frank H. West. The Calumet special quadrangle, in Houghton and Keweenaw counties, and the Fowlerville and Mason quadrangles, in Livingston and Ingham counties, were controlled by 191 miles of primary traverse run and 37 stations established by J. R. Ellis.

Minnesota.—The survey of the Rockford quadrangle, in Hennepin and Wright counties, was completed by J. G. Staack, the area surveyed being 211 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this quadrangle 74 miles of primary levels were run and 15 permanent bench marks were established by Edward Bandli.

Missouri.—For the continuation of cooperative topographic surveys in Missouri the state geologist and the United States Geological Survey each allotted $5,000. The resurvey of the Ste. Genevieve quadrangle was continued, which resulted in the completion of the Weingarten quadrangle, in Ste. Genevieve and Perry counties, by C. G. Anderson, and the survey of the Higdon quadrangle, in the same region, was commenced. The survey of the Macon quadrangle, in Macon, Shelby, Monroe, and Randolph counties, was commenced by Merrill Hackett. The total area resurveyed was 407 square miles and the new area surveyed was 229 square miles, all for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 134 miles of primary levels were run and 22 permanent bench marks were established by Edward Bandli; and 164 miles of primary traverse were run and 14 stations established by J. R. Ellis. The Sullivan quadrangle, in Franklin and Crawford counties, was controlled by 26 miles of precise levels by E. L. McNair, who set 8 permanent bench marks.

Oklahoma.—The governor of Oklahoma and the United States Geological Survey each allotted $4,000 for the continuation of cooperative topographic surveys in that State. The work on the Luther, Merrick, Maud, and Shawnee quadrangles, in Lincoln, Logan, Oklahoma, Payne, Pottawatomie, and Seminole counties, was completed, and that on the Newalla and Burnett quadrangles, in Cleveland, Lincoln, Oklahoma, and Pottawatomie counties, was nearly completed. This work was done by C. L. Sadler, H. H. Hodgeson, and L. B. Roberts, the total area surveyed being 767 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these and adjacent areas 241 miles of primary levels were run and 95 permanent bench marks were established by F. M. Hutchinson, and 194 miles of primary traverse were run and 30 stations established by J. R. Ellis. In addition to the cooperative work, the survey of the Wyandotte quadrangle, in the Cherokee Nation, was completed by C. G. Anderson and J. A. Duck, the total area surveyed being 401 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

Texas.—The survey of the San Marcos quadrangle, in Caldwell, Hays, Comal, Gonzales, and Guadalupe counties, was completed by Fred McLaughlin, W. J. Forster, and D. B. Penick, the total area surveyed being 469 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet. For the control of the Mount Pleasant, Bassett, Boxelder, and Daingerfield quadrangles, in Bowie, Red River, Morris, Cass, and Titus counties, 217 miles of primary levels were run and 61 permanent bench marks were established by W. A. Gelbach, and 98 miles of primary traverse were run by F. J. McMaugh.

Wisconsin.—The survey of the Cross Plains quadrangle, in Dane County, was completed by A. T. Fowler; that of the Sparta quadrangle, in Monroe and La Crosse counties, was completed by Merrill Hackett; and that of the Fond du Lac quadrangle, in Fond du Lac and Winnebago counties, was commenced by H. L. McDonald, the total area mapped being 176 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The revision of the Oconomowoc quadrangle, covering 218 square miles in Waukesha, Dodge, and Washington counties, was completed by A. T. Fowler, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The Fond du Lac and Menasha quadrangles, in Fond du Lac, Winnebago, and Calumet counties, and the Stoughton and

Waterloo quadrangles, in Dodge, Jefferson, Dane, and Polk counties, were partly controlled by J. R. Ellis, who ran 184 miles of primary traverse, and by H. L. McDonald, who ran 15 miles of levels. The De Soto quadrangle, in Franklin County, was partly controlled by E. L. McNair, who ran 28 miles of precise levels and established 8 permanent bench marks.

DRAINAGE SURVEYS IN MINNESOTA.

A further appropriation of $10,000 was made by Congress in the Indian act for the continuation of the survey of the swamp areas in the ceded lands of the Chippewas in Roseau, Beltrami, Marshall, Red Lake, and Koochiching counties, the work being assigned to the Geological Survey by the Secretary of the Interior. The work was prosecuted by A. P. Meade and E. L. McNair, and approximately 1,800 square miles were covered by a network of levels, 188 miles of precise levels and 272 miles of primary levels being run, in connection with which 79 permanent bench marks were established.

OFFICE WORK.

The drafting of the following sheets was completed: West Frankfort and Tallula, Ill.; Howell, Mich.; Rockford, Minn.; Weingarten and Wyandotte, Mo.; Perkins, Maud, Shawnee, and Luther, Okla.; New Boston, Texarkana, and Linden, Tex.; Cross Plains, Sparta, and Oconomowoc, Wis. Progress was made on the drafting of sheets as follows: Carlyle and Hardinville, Ill., and Macon, Mo., 50 per cent each; Burnett, Okla., 85 per cent; Bloomington, Ind., 47 per cent; Fort Leavenworth special, Kans.-Mo., 45 per cent; Milo, Iowa, 35 per cent.

In the triangulation and computing section the following computations were made:

For the control of the DeQueen (Ark.) quadrangle, 1,055 latitudes and departures and 100 geographic positions were computed.

For the control of the Hardinville, Okawville, New Athens, and Carlyle (Ill.) quadrangles, 913 latitudes and departures and 209 geographic positions were computed. The final computation of the precise-level line in Edgar County, Ill., was made. Level circuits were adjusted in the Okawville, New Athens, Baldwin, Carlyle, Hardinville, Herrin, and Murphysboro quadrangles, all in Illinois.

The final computation of the precise level line extending through Clay and Vigo counties, Ind., was made and primary-level circuits in the Bloomington (Ind.) quadrangle were adjusted.

For the control of the Milo (Iowa) quadrangle, 292 latitudes and departures and 55 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Calumet (Mich.) special quadrangle, 554 latitudes and departures and 57 geodetic positions were computed.

Level circuits in the Howell and Milford (Mich.) quadrangles were adjusted.

Level circuits in the Rockford and Elk River (Minn.) quadrangles were adjusted.

For the control of the Edmond, Luther, Moore, Norman, Newalla, and Burnett (Okla.) quadrangles, 1,800 latitudes and departures and 212 geographic positions were computed. Level circuits in the same area were adjusted.

For the control of the Bassett, Boxelder, Daingerfield, and Mount Pleasant (Tex.) quadrangles, 816 latitudes and departures and 82 geographic positions were computed.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic surveying was carried on in Colorado, Montana, North Dakota, New Mexico, and Wyoming. The survey of 7 new quadrangles and of 2 special areas was completed; also the resurvey of 1 quadrangle and 1 special area. In addition 4 new quadrangles were partly surveyed and 3 were partly resurveyed. The total new area mapped was 5,188 square miles—3,804 for publication on the scale of 1:125,000, 1,347 for publication on the scale of 1:250,000, 35 for publication on the scale of 1:24,000, and 2 for publication on the scale of 1:12,000. The area resurveyed was 759 square miles for publication on the scale of 1:125,000. In connection with this work 510 miles of primary levels and 80 miles of precise levels were run and 161 permanent bench marks were established.

Triangulation and precise leveling were carried on by four parties. This work was distributed over Montana, New Mexico, and Wyoming, covering an area of about 5,400 square miles and furnishing control for nine 30-minute quadrangles and one special quadrangle.

Topographic surveys in Rocky Mountain division from June 1, 1907, to July 1, 1908.

State.	Contour interval.	For publication on scale of—				Levels.	
		1:125,000.		1:250,000.	Total area surveyed.	Distance run.	Bench marks.
		New.	Resurvey.	New.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Colorado	50–100	1,130	615	....	[a] 1,817	213	70
Montana	50–100	585	20	1,203	1,808	110	31
New Mexico	100	1,218	....	....	[b] 1,255	252	55
North Dakota	50	....	....	144	144	....	....
Wyoming	100	871	124	....	995	15	5
		3,804	759	1,347	6,019	590	161

[a] 72 square miles of resurvey in Colorado for publication on the scale of 1 : 48,000.

[b] In New Mexico 35 square miles for publication on the scale of 1 : 24,000 and 2 square miles for publication on the scale of 1 : 12,000.

DETAILS OF WORK BY STATES.

Colorado.—The survey of the Livermore quadrangle, in Larimer County, was completed, and that of the Eaton quadrangle, in Larimer and Weld counties, was commenced by Frank Tweedy, Dave Winbray, H. S. Starr, and G. W. Lucas, the area covered being 267 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The resurvey of areas in El Paso, Fremont, and Teller counties was continued by R. T. Evans, D. F. C. Moor, and H. R. Elliott, and resulted in the completion of the work on the Colorado Springs quadrangle and the Pikes Peak special area, the former including 575 square miles, surveyed for publication on the scale of 1:125,000, with a contour interval of 100 feet, and the latter 72 square miles, for publication on the scale of 1:48,000, with a contour interval of 50 feet. A special line of levels was run from a bench mark at Manitou to the top of Pikes Peak for the purpose of accurately establishing the elevation of the peak, 20 miles of levels being run and 10 permanent bench marks established by Charles Hartmann, jr. The survey of the Ignacio quadrangle, in the San Juan National Forest, in La Plata County, was completed by Frank Tweedy, Gilbert Young, and Lee Morrison. This area includes the Durango quadrangle, the total new area mapped being 713 square miles. In connection with this work the mapping of 40 square miles of the Engineer Mountain quadrangle was revised by Mr. Tweedy. The survey of the Mount Jackson quadrangle, in the Holy Cross National Forest, in Pitkin and Eagle counties, was commenced by Fred McLaughlin and D. F. C. Moor, the area surveyed being 150 square miles. This work was done for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the partial control of the Eaton quadrangle 24 miles of primary levels were run and 7 permanent bench marks were established by W. R. Winstead. For the control of the Ignacio quadrangle and adjacent areas 70 miles of primary levels were run and 23 permanent bench marks were established by F. A. Nussle. For the partial control of the Cebolla quadrangle, in Gunnison and Hinsdale counties, 19 miles of primary levels were run and 5 permanent bench marks were established by R. T. Thompson. For the control of the Breckenridge special quadrangle, in Summit County, a line of precise levels was begun by C. H. Semper, 80 miles being run and 25 permanent bench marks established. D. F. C. Moor also occupied 8 stations by triangulation for the control of the same area.

Montana.—The survey of the Sapphire quadrangle, in the Hellgate National Forest, was completed, and that of the Missoula quadrangle, in the Lolo National Forest, was commenced by J. F. McBeth, J. E. Tichenor, W. J. Forster, and Arthur Stiles, the total area surveyed being 492 square miles in Granite, Ravalli, and Missoula counties, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Mr. McBeth also revised 20 square miles of the Philipsburg quadrangle, in Granite County. For the control of the Missoula quadrangle 84 miles of primary levels and 27 permanent bench marks were established by N. W. Pilger. The survey of the Nyack quadrangle, in the Lewis and Clark National Forest, in Flathead County, was commenced by Arthur Stiles, the area surveyed being 93 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area 26 miles of primary levels and 4 permanent bench marks were established by Charles Hartmann, jr.

Montana-North Dakota.—The survey of the Glendive quadrangle, in Dawson County, Mont., and Billings County, N. Dak., was completed by D. F. C. Moor, the total area surveyed being 1,347 square miles, for publication on the scale of 1:250,000, with a contour interval of 50 feet, 144 square miles being in North Dakota. Additional control for the Glendive quadrangle was obtained by Mr. Moor, who located 7 points by means of triangulation.

New Mexico.—The survey of the Gallina quadrangle, in the Jemez National Forest, in Rio Arriba County, was completed by Gilbert Young, Lee Morrison, and S. T. Penick, the total area surveyed being 250 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In connection with this work 11 miles of primary levels were run and 3 permanent bench marks were established by F. A. Nussle. The survey of the Silver City and Santa Rita special quadrangles, in the Gila and Big Burro national forests, in Grant County, was completed by A. B. Searle, J. H. Sinclair, Gilbert Young, S. T. Penick, Charles Hartmann, jr., Frank Tweedy, and D. F. C. Moor, the former consisting of 968 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, and the latter of 35 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet. For the control of this work 214 miles of primary levels were run and 45 permanent bench marks were established by Victor Mindeleff. The survey of the Fort Bayard special quadrangle, in Grant County, consisting of 2 square miles, was completed by C. E. Cooke, for publication on the scale of 1:12,000, with a contour interval of 10 feet. For the control of this area Mr. Cooke occupied 10 stations by triangulation and Stuart T. Penick ran 27 miles of primary levels and established 7 permanent bench marks. The Silver City quadrangle was controlled by Fred McLaughlin, who located 9 new points by triangulation.

Wyoming.—The survey of the Grosventre quadrangle, in the Yellowstone National Forest, in Uinta and Fremont counties, was completed by T. M. Bannon, W. M. Kent, and W. S. Sargent, the area surveyed being 871 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Messrs. Bannon, Kent, and R. T. Evans also completed 124 square miles of revision on the Laramie quadrangle, in Albany County. The Hoback, Grays River, Cora, and Grosventre quadrangles, in Uinta County, were controlled by R. B. Robertson, who located 8 primary and 19 secondary triangulation points. For the control of the Rock Springs quadrangle, in Sweetwater County, J. D. Weems ran 15 miles of primary levels and established 5 permanent bench marks.

OFFICE WORK.

The drafting of the following sheets was completed: Livermore, Ignacio, Colorado Springs, and Pikes Peak special, Colorado; Glendive and Sapphire, Montana; Gallina, Silver City, and Santa Rita special, New Mexico; Grosventre and Medicine Bow, Wyoming. Progress amounting to 14 per cent was made in the drafting of the Laramie (Wyo.) sheet.

In the triangulation and computing section the following computations were made:

Level circuits in the Durango and Pagosa (Colo.) quadrangles were adjusted.

A least-square figure adjustment was made of the triangulation for the control of the Glendive (Mont.) quadrangle, and the final computation was made of the geodetic distances and positions of all stations within that area. The least-square adjustment and final computation of triangulation stations in the Blackfeet Indian Reservation were completed, and level circuits in the same area were adjusted.

The least-square adjustment of triangulation stations for the control of the Silver City (N. Mex.) quadrangle was made, and the final geodetic distances and positions of 9 stations were computed. Level circuits were adjusted in the Bloomfield, Dulce, Farmington, and Lumberton (N. Mex.) 30-minute quadrangles.

The least-square adjustment of the triangulation for the control of the Hoback, Grays River, Cora, and Grosventre (Wyo.) quadrangles, and the final computation of the geodetic positions of primary-traverse stations and of many of the secondary stations were made.

PACIFIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic surveying was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. The survey of 3 new quadrangles and 2 special areas and the resurvey of 15 quadrangles were completed. In addition 6 new quadrangles and

1 special area were partly surveyed and 10 quadrangles were partly resurveyed. The total new area mapped was 8,372 square miles—4,383 for publication on the scale of 1:125,000, 250 for publication on the scale of 1:62,500, and 3,739 for publication on the scale of 1:250,000. The area resurveyed was 2,331 square miles—1,441 for publication on the scale of 1:125,000, and 890 for publication on the scale of 1:62,500. In connection with this work 1,991 miles of primary levels and 128 miles of precise levels were run and 477 permanent bench marks were established. Primary control was carried on at various times by six parties. This work was distributed over portions of California, Idaho, Oregon, Utah, and Washington. The total area covered by this primary control is about 15,300 square miles, of which 450 square miles were controlled by primary traverse.

Topographic surveys in Pacific division from June 1, 1907, to July 1, 1908.

State.	Contour interval.	For publication on scale of—					Total area surveyed.	Levels.	
		1:125,000.		1:62,500.	1:250 000.	1:31,680.		Distance run.	Bench marks.
		New.	Resurvey.	New.	New.	Resurvey.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Arizona	50-100		579	250			829	155	54
California	5-10-100 100	2,998				890	3,888	1,076	233
Idaho	100	162					162	287	62
Nevada	100				3,739		3,739	268	51
Oregon	50-100	1,058					1,053	224	53
Utah	100		862				862	40	8
Washington	50-100	170					170	69	16
		4,383	1,441	250	3,739	890	10,703	2,119	477

DETAILS OF WORK BY STATES.

Arizona.—A resurvey of the area covered by the San Francisco Mountains reconnaissance map, consisting of the Flagstaff quadrangle, in the San Francisco Mountains National Forest, in Coconino County, was commenced by Pearson Chapman, the area surveyed being 579 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area 155 miles of primary levels were run and 54 permanent bench marks were established by T. A. Green. The survey of the Troy quadrangle, in Pinal and Gila counties, was completed by Pearson Chapman and C. F. Eberly, the area surveyed being 250 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

California.—The Department of Engineering of California allotted $12,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted a like sum for the same purpose. In the Sacramento Valley the resurvey of the areas covered by the Lodi and Sacramento reconnaissance maps was undertaken and resulted in the completion of the work in 14 quadrangles, the Carbondale, Goose Creek, Clements, Cosumnes, Clay, Lockeford, Waterloo, Castile, Headreach, Galt, Elkgrove, Franklin, Bruceville, and Linden, in Sacramento, San Joaquin, Solano, and Amador counties; and the partial completion of work in the New Hope, Woodbridge, Mills, Antelope, Arcade, Folsom, Pleasant Grove, and Roseville quadrangles. This work was done by W. R. McKean, B. A. Jenkins, E. R. Bartlett, R. M. LaFollette, Bayard Knock, and M. A. Knock, the total area resurveyed being 890 square miles, for publication on the scale of 1:31,680, with contour intervals of 5 and 10 feet. For the control of these quadrangles 373 miles of primary levels were run and 61 permanent bench marks were established by L. F. Biggs and B. A. Jenkins. In addition to the cooperative surveys a map was made of the Coalinga and the McKittrick-Sunset oil districts, which occupy an irregular strip in Fresno, Kings, San Luis Obispo, and Kern counties, consisting of 2,324 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This work was done by E. P. Davis, G. R. Davis, J. W. Muller, J. E. Blackburn, and R. M. LaFollette. The survey of the Big Bar quadrangle, in the Trinity National Forest, in Trinity County, was commenced by J. P. Harrison; and that of the Mount Goddard and Bishop quadrangles, in the Sierra National Forest, in Fresno and Inyo counties, was commenced by G. R. Davis, the area surveyed by both being 674 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the noncooperative work in California 602 miles of primary spirit levels were run and 155 permanent bench marks were established by L. F. Biggs. Triangulation control for the Weaverville, Big Bar, Sawyers Bar, and Seiad Valley quadrangles, in Trinity and Siskiyou counties, was completed by C. F. Urquhart, who occupied 21 triangulation stations, 7 of which are Coast and Geodetic Survey points. Control for ten 15-minute quadrangles in the Sacramento Valley, in Sacramento, San Joaquin, Amador, Eldorado, Placer, Sutter, Yuba, and Butte counties, was completed by Mr. Urquhart and C. L. Nelson, 76 new triangulation stations being established. For the control of the Woodbridge and Galt quadrangles, in Sacramento and San Joaquin counties, Mr. Urquhart ran 44 miles of primary traverse. For the additional control of the Davisville, Clarksburg, and Rio Vista quadrangles, in Sacramento and San Joaquin counties, 101 miles of precise levels were run and 17 permanent bench marks were established by L. F. Biggs.

Idaho.—The survey of the Meadows quadrangle, in the Weiser National Forest, in Washington and Boise counties, was commenced by C. F. Eberly and J. G. Hefty, the area surveyed being 162 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet. For the control of this and adjacent areas 287 miles of spirit levels were run and 62 permanent bench marks were established by Mr. Hefty and D. A. Maxwell.

Idaho-Oregon.—The Cambridge and Meadows 30-minute quadrangles, in Washington and Boise counties, Idaho, and Union County, Oreg., were controlled by G. T. Hawkins, who located 9 triangulation points.

Idaho-Wyoming-Utah.—The Montpelier, Cokeville, Evanston, and Kemmerer quadrangles, in Bear Lake County, Idaho, Uinta County, Wyo., and Rich County, Utah, were controlled by G. T. Hawkins, who located 13 triangulation points.

Nevada.—The survey of the Tonopah quadrangle, covering an area of 3,739 square miles in Esmeralda and Nye counties, was completed by J. E. Blackburn, for publication on the scale of 1 : 250,000, with a contour interval of 100 feet. For the control of this area 268 miles of primary levels were run and 51 permanent bench marks were established by T. A. Green.

Oregon-Washington.—For the continuation of cooperative topographic surveys in Oregon the state engineer allotted $2,500 and the United States Geological Survey allotted a like sum. The survey of the Umatilla quadrangle, in Morrow and Umatilla counties, Oreg., and Klickitat County, Wash., was completed by C. H. Birdseye, C. F. Eberly, C. E. Giffin, and Robert Muldrow, and that of the Eugene quadrangle, in Lane County, Oreg., was begun by J. P. Harrison and C. E. Giffin. The area surveyed was 837 square miles, 113 of which are in Washington, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet. For the control of this area 135 miles of primary levels were run and 32 permanent bench marks were established, 30 miles of levels and 9 bench marks being in Washington. In addition to the cooperative mapping, the survey of the Mount Hood special area, in the Bull Run National Forest, in Clackamas and Multnomah counties, was continued by A. H. Sylvester and Ralph Cowgill, the area completely covered being 329 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet. For the control of this and adjacent areas 92 miles of primary levels were run and 24 permanent bench marks were established by John R. Evans. A line of precise levels was begun by L. F. Biggs, 27 miles being completed, and 6 permanent bench marks were established.

The Umatilla quadrangle, in Morrow and Umatilla counties, Oreg., and Klickitat County, Wash., and the Pasco, Wallawalla, Wallula, and Dayton quadrangles, in Benton, Columbia, Garfield, and Wallawalla counties, Wash., were controlled by A. H. Sylvester and G. T. Hawkins, 19 triangulation points being located.

Utah.—The resurvey of a portion of the area covered by the Salt Lake reconnaissance map, in the Uinta National Forest, in Wasatch, Summit, and Utah counties, was begun by A. E. Murlin, who completed the work on the Strawberry Valley quadrangle and commenced that on the Soldier Summit quadrangle, the total area resurveyed being 862 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Calleo quadrangle, in Millard County, T. A. Green ran 40 miles of primary levels and established 8 permanent bench marks.

Washington.—The survey of the Mount Baker quadrangle, in the Washington National Forest, in Whatcom and Skagit counties, was commenced by Robert Muldrow, the area surveyed being 57 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this quadrangle 39 miles of primary levels were run and 7 permanent bench marks were established by Homer M. Hadley.

OFFICE WORK.

The drafting of the following sheets was completed: Carbondale, Goose Creek, Clements, Cosumnes, Clay, Lockeford, Waterloo, Castile, Woodbridge, Galt, Elkgrove, Franklin, Bruceville, Linden, Antioch (first named Montezuma), and Coalinga and McKittrick-Sunset oil districts, California: Tonopah, Nev.; Umatilla, Oreg.; and Strawberry Valley, Utah. Progress was made in the drafting of sheets as follows: Flagstaff, Ariz., 43 per cent; New Hope, Cal., and Mount Hood special, Oregon, each 50 per cent.

In the triangulation and computing section the following computations were made:

Level circuits in the Bowie, Chiricahua, Pearce, Wilcox, Flagstaff, Grandview, and Williams quadrangles, in Cochise and Coconino counties, Ariz., were adjusted.

Office computation was made of the precise line of levels from Sacramento, Cal., down the river. Primary-level circuits in the Folsom, Galt, Hatchville, Ione, Lockeford, Stockton, and Woodbridge (Cal.) quadrangles were adjusted. The least-square adjustment of the triangulation done in California in 1907 was made in the Sacramento office.

For the control of the Cambridge and Meadows 30-minute quadrangles (Idaho-Oregon) the least-square figure adjustment and final computation of geodetic distances and positions were made. Level circuits in the same area were adjusted. For the control of the Montpelier, Cokeville, Evanston, and Kemmerer quadrangles, in Bear Lake County, Idaho, Uinta County, Wyo., and Rich County, Utah, the least-square figure adjustment of the triangulation was made and the geodetic positions of 13 triangulation stations were computed.

For the completion of the control of the Furnace Creek and Las Vegas (Nev.) quadrangles computation was made of the approximate positions of certain points located during the preceding season. Level circuits in the Tonopah (Nev.) quadrangle were adjusted.

The least-square figure adjustment and final computations of geodetic distances and positions of triangulation stations for the control of the Umatilla, Benton, Pasco, Wallawalla, Wallula, and Dayton quadrangles (Wash.-Oreg.) were made. Level circuits in the Blalock Island and Umatilla quadrangles, in the same States, were adjusted.

COMPILATION OF SPECIAL NATIONAL-FOREST MAPS.

The work of preparing the folios of the atlas of the national forests was continued under the direction of A. C. Roberts.

The maps were made on the scale of 1 mile to the inch and published with 6 townships to the page. All the work of the United States Geological Survey, the General Land Office, and the Hayden, Transcontinental, and Wheeler surveys, as well as that of private surveys, was incorporated in the maps. The status of all lands inside of the forests was obtained in greatest detail from the records of the General Land Office by expert status clerks, and the land classification and the improvements in the forests from the maps of the Forest Service, all these data being shown in colors and symbols on the compiled maps.

Folios were finished during the fiscal year 1907–8 for the following forests: Gallatin, Chiricahua, Lewis and Clark, Manti, Payson, Beaver, Wichita, Trinity, Olympic, Sawtooth, Klamath, Madison, Blue Mountain, Mount Graham, Big Belt, Wasatch, Bitterroot, Priest River, Sierra Madre, Bear River, Siskiyou, Prescott, San Gabriel, and Holy Cross.

The maps were nearly completed for the Hell Gate, Stanislaus, Battlement Mesa, and San Bernardino forests. The Gunnison, Cochetopa, and Tahoe forest maps were about one-half completed, and work was started on the maps of the Lolo, Arkansas, Grand Canyon, Huachuca, La Sal, Santa Catalina, Santa Rita, and Monticello forests.

The work was greatly retarded during the latter part of the year owing to changes in boundaries and redistricting of national forests.

INSTRUMENTS AND TOPOGRAPHIC RECORDS.

During the year all the topographic instruments in the office were examined, and all those found to be worn out, useless, or of obsolete types were condemned by a committee appointed by the Director. Some of these were deposited in the National Museum and the remainder were sold at auction. There were purchased ten 15-inch Y levels, nine telescopic alidades, twenty 20-foot leveling rods, two

6-inch transits, three aneroid barometers, and sixteen steel tapes; also an air pump connected with a mercurial barometer for testing aneroids and an apparatus for engraving numbers on instruments, both of which have already proved their usefulness. All minor repairs to instruments were made in the Survey shop, the extensive repairs or remodeling being done by outside contractors as heretofore.

A change in the system of filing topographic records was adopted whereby the work of cataloguing is materially reduced. There were 2,225 new records catalogued and filed. The triangulation and leveling plats of all States, the card catalogue of triangulation and primary-traverse stations, and the card catalogue of bench-mark descriptions and elevations were brought up to date.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

During the field season inspection of topographic mapping, completed or in progress, was carried on by J. H. Renshawe in the northeastern and central portions of the United States, by W. M. Beaman in the southeastern and central parts, and by François E. Matthes in the western part. All States in which work was in progress were visited during the season, and the parties were instructed for the purpose of maintaining uniformity of style and system in the expression of topographic features.

During the office season careful attention was given by the inspectors to the final drawing of topographic sheets, for the purpose of eliminating personal characteristics and errors of expression.

WATER-RESOURCES BRANCH.

ORGANIZATION.

During the last year an effort has been made to maintain as much as possible of the investigations of the water resources of the country—work formerly carried on under larger but still insufficient appropriations. The work performed may be divided, as formerly, into three parts: First, the investigation of stream flow and allied problems; second, the investigation of the occurrence, sources, and amounts of underground waters in various portions of the country; and third, the investigation of the quality of water, both surface and underground. A combination of these three investigations is necessary to afford the data for the determination of water resources required in the appropriation act.

The work was carried on under the direction of M. O. Leighton, chief hydrographer, assisted by John C. Hoyt, assistant chief hydrographer. The chief hydrographer was designated as advisory hydrographer to the Inland Waterways Commission, and in that capacity presented a report on the possibility of preventing floods and assisting navigation in the Ohio Valley by the construction of upland reservoirs, which has been widely discussed in engineering and popular journals.

STREAM-FLOW INVESTIGATIONS.

The total number of river-measurement stations maintained by the water-resources branch during the fiscal year 1907-8 was 630, of which 367 stations were carried on independently by the Geological Survey and 263 stations were maintained in cooperation with other organizations.

New York and New England district.—The great reduction in the appropriation for the past fiscal year rendered it necessary to discontinue a large amount of work in this as in other districts.

Stream measurements were made in this district at 53 stations, and, in addition, river profiles and lake surveys were made in cooperation with the Survey Commission of the State of Maine. These surveys covered Chamberlain, Allegash, and Telos lakes, in the Allegash River drainage; Webster, Second, and Grand lakes, in the East Branch of Penobscot River drainage; Baskahegan and Mattawamkeag lakes, in the Mattawamkeag River drainage; Mattawamkeag River from mouth to mouth of Baskahegan Stream; Schoodie, Seboois, and Endless lakes, and Pleasant Pond, in the Piscataquis River drainage. The amount appropriated by the State of Maine was $3,200.

The State of New York also cooperated in stream-measurement work, the state legislature having granted authority to the state engineer to expend $1,500 for this purpose. This sum was applied to the maintenance of 13 stations. The New York state water supply commission, charged with the duty of making a report on water powers within the State, availed itself of the organization of the Geological Survey for the maintenance of 6 stations in connection with its work. The total amount appropriated by the state water supply commission for this purpose was $1,950.

A report on the hydrography of the Penobscot River basin, dealing with stream flow, quality of water, floods, navigation, water power, and water storage, was in preparation during the year and is nearly completed.

Work in this district was under the charge of H. K. Barrows, district engineer.

Middle Atlantic States district.—In this district, which covers the States of Pennsylvania, New Jersey, Maryland, Virginia, and West Virginia, a large part of the work was discontinued for lack of funds. Thirteen stations were, however, maintained by the Geological Survey, in addition to the Pennsylvania stations, the expenses of which were borne by the state water supply commission of Pennsylvania. The stations maintained in the State of Maryland were supported through the cooperation of W. B. Clark, state geologist.

Work in this district was under the charge of J. C. Hoyt, assistant chief hydrographer.

Southern Atlantic States district.—The act of Congress authorizing the Secretary of Agriculture to investigate and report on the watersheds of the southern Appalachian and White Mountain regions, with reference to the advisability of the Government purchasing and setting apart these regions as national forest reserves, made it possible to increase the work in this district. The Secretary of Agriculture requested the Director of the Geological Survey to take up the stream investigations involved in this work and made an allotment therefor of $6,000. Reports on the relation of the southern Appalachian Mountains to water power and to inland navigation were presented to the Department of Agriculture and printed as two circulars of the United States Forest Service, and a third report, on floods, is now being prepared.

Stream measurements were made in this district during the year at 106 stations, 43 of which were maintained from the appropriation above referred to. The work in the district was under the charge of M. R. Hall, district engineer.

Central States district.—The important investigations in this district that were temporarily discontinued during the fiscal year 1907 on account of the great reduction in appropriation were resumed during the latter part of the fiscal year 1908. These investigations, relating to the seasonal distribution of stream flow and its relation to floods, to navigation, and to water power, are being vigorously pushed.

There were 39 stations maintained in this district, and the work was under the charge of A. H. Horton, district engineer.

Missouri River district.—In this district, which includes the States of North Dakota, South Dakota, Montana, and northern Wyoming, 82 stream-measurement stations were maintained, and the work was confined chiefly to those streams available for irrigation. In the maintenance of stations connected with irrigation projects under construction the United States Reclamation Service cooperated.

Work in this district was directed by Robert Follansbee and, later, by J. E. Stewart, district engineer.

Denver district.—This district includes the States of Colorado, southern Wyoming, Nebraska, Kansas, Oklahoma, and Texas and the Territory of New Mexico. Of the 72 river-measurement stations maintained in the district during the year, 13 were located on irrigation projects, and the expenses of these were paid by the United States Reclamation Service.

As this district holds the sources of some of the most important streams of the country, the work here is of especial importance. The memorable suit between the State of Kansas and the State of Colorado concerning the diversion of the waters of Arkansas River has emphasized the necessity of procuring more accurate data concerning all matters relating to the utilization of water. The results of suits of this kind not only have local interest but are highly important from a national standpoint, as, with the growth of the country, interstate suits growing out of stream diversion will doubtless become more frequent.

The work in this district was under the charge of W. B. Freeman, district engineer.

Great Basin district.—In this district, which comprises the States of Idaho, Utah, and Nevada, stream measurements were made at 50 stations. The United States Reclamation Service cooperated in the maintenance of project stations in all three of these States, while additional cooperation was rendered by the state engineer of Nevada.

Work in this district was under the direction of E. C. LaRue, district engineer.

Columbia River district.—The district including the States of Washington and Oregon contains water resources of notable interest and value. The region is drained by the Columbia, one of the largest rivers on the continent, a stream of interstate and national importance. Although enormous developments have taken place in this district, it can hardly be said that more than a beginning has been made, and the necessity for thorough knowledge of the water resources in advance of settlement is fully realized. The United States Government owns vast areas in this region, and a further postponement of extensive investigations can not be justified under any proper standard of governmental administration.

Forty-five stations were maintained in Washington and 67 stations in Oregon. The work in Oregon was conducted in cooperation with the state engineer.

The work in this district was directed by J. C. Stevens, district engineer.

California district.—The work in California was carried on in cooperation with the State, a liberal appropriation having been made by the state legislature in response to the demand of citizens who realize that industrial development is almost absolutely dependent on a systematic investigation of water resources.

River measurements were made at 73 stations, and observations and surveys looking to the diffusion of information concerning the conservation of water supplies were also made.

The stream-measurement work in this district was under the direction of W. B. Clapp, district engineer.

In addition to the direct investigation of stream flow throughout the State, an investigation of the laws of transportation of suspended material in rivers was carried on in the hydraulic laboratory maintained at Berkeley. This investigation is one of the most important ever undertaken by the United States Government, for it affects questions of navigation and irrigation throughout the country. The Government has expended many millions of dollars in removing from river channels the débris brought down by floods, and this annual expenditure for dredging may be expected to continue until a scientific study of the whole question of débris transportation shall have found a solution to the problem. This investigation is an integral part of the whole purpose of the Survey's water investigations, namely, the ascertainment of the basic facts upon which future corrective development of river channels must depend.

The débris investigation was under the charge of G. K. Gilbert, geologist, the work being conducted in cooperation with the geologic branch.

GROUND-WATER INVESTIGATIONS.

Investigations of the underground waters of the United States were continued during the fiscal year 1907–8 as during previous years, except that as the appropriations were less the work was necessarily continued on a reduced scale.

The most comprehensive general investigation under way during the year in this division was that of the ground waters of the Atlantic Coastal Plain. This work was undertaken as a result of a cooperative agreement entered into between the United States Geological Survey and the state geologists of the Coastal Plain States. The geologic and water-resources branches of the Survey shared the federal portion of the expense, and the work was placed under the general direction of M. L. Fuller, continuing under his charge until his resignation from the Survey in the autumn of 1907. T. Wayland Vaughan was then named as federal representative, and the work was continued under his supervision.

Toward the close of the year work in the Coastal Plain of Texas, which had been pursued as an independent investigation, was placed under Mr. Vaughan's charge, for the reason that the Texas Coastal Plain is, in all essential particulars, a part of the general Coastal Plain province.

Prof. C. H. Gordon completed during the summer of 1907 the field work involved in two investigations in northern Texas, one covering the north-central portion of the State and the other the northeastern portion. Professor Gordon resigned from the Survey to accept a position as professor of geology in the University of Tennessee, entering upon his duties with the beginning of the school year. His university duties interfered with the preparation of his federal reports, but these were taken up at the end of May, and by July 1 substantial progress had been made on the report on north-central Texas. That on northeastern Texas will be delayed.

A report in preparation by Prof. H. E. Gregory, of Yale University, on the ground waters of Connecticut was submitted during the year and at its close was undergoing revision.

A report by Prof. A. F. Crider on the ground waters of eastern Arkansas was likewise submitted toward the close of the year and is undergoing revision.

A report by George C. Matson on the ground waters of the bluegrass region of Kentucky, prepared as a result of field work carried out during the previous fiscal year, was submitted for publication toward the close of the year.

A report by F. G. Clapp on the ground waters of southern Maine, prepared as a result of field work carried out during previous years, was forwarded for publication toward the close of the fiscal year.

Substantial progress has been made in the preparation of a report on the ground waters of the State of Iowa, in which Prof. W. H. Norton, of Cornell College, Mount Vernon, Iowa; Prof. W. S. Hendrixson, of Iowa College, Grinnell, Iowa; and H. E. Simpson, of the United States Geological Survey, cooperated.

The preparation of a report on the ground waters of southern Minnesota has been continued during the year by O. E. Meinzer, acting in cooperation with Prof. C. W. Hall, of Minneapolis. Mr. Meinzer's share of the work was completed at the end of the year, and it is expected that Professor Hall's portion will soon be finished.

Work in the three Pacific Coast States has been continued under the general direction of W. C. Mendenhall. As a result of this work a report on the ground waters of south-central Oregon, by G. A. Waring, was submitted and sent to the Public Printer toward the close of the year. Field work was completed by Mr. Waring as a basis for reports on the ground waters of the Harney basin, in southern Oregon, and on the ground waters of the lower Yakima Valley, in Washington. The Harney basin report was submitted for publication, and that on the Yakima Valley is well advanced toward completion. Reports were submitted during the year and have been sent forward for publication on the ground waters of the Indio region, California, by W. C. Mendenhall, and on the foothill belt of southern California by the same author.

At the close of the year Mr. Mendenhall had under way a preliminary report on the ground waters of the San Joaquin Valley, and a bulletin which will embody the geologic results attained as an incident to the ground-water investigations in this field.

In January Mr. Mendenhall, whose headquarters had theretofore been in Los Angeles, Cal., was recalled to the Washington office, and at the close of the year he was given general charge of the underground-water work in the United States.

INVESTIGATIONS OF QUALITY OF WATER.

Investigations of quality of water have been made under the general supervision of R. B. Dole, assisted by Herman Stabler, H. N. Parker, W. D. Collins, E. B. Phelps, Chase Palmer, and others.

Surface waters of the United States.—The most important investigation of quality of water conducted during the year has been the continuation of a study of surface waters commenced in 1906, as detailed in the report of last year. In connection with this work more than 50,000 samples of water have been collected from the principal lakes and streams of the United States, and about 4,800 analyses have been made. The analytical work of this study has been completed and the water-testing laboratories that were established for its performance have been discontinued. Reports are now being prepared discussing the analytical results in relation to industrial and municipal uses of water, chemical denudation, and other features.

Analyses of underground waters.—Besides the tests of surface waters, about 300 mineral analyses of well and spring waters have been made in connection with underground-water investigations in Florida, Indiana, Kentucky, Virginia, and Texas. It has been demonstrated that much more economical and satisfactory results are obtained by making water analyses in laboratories established and maintained by the Survey than by paying private laboratories for such work or depending on miscellaneous analyses that may have been made on waters from the regions under study. Several reports involving results of work of the water-testing laboratories on underground waters have been prepared for publication.

California.—In cooperation with the state board of examiners of California, the investigation of the quality of surface waters in that State has been continued. A chemical laboratory under the direction of Walton Van Winkle, assistant chemist, has been established at Berkeley, where samples of water from stations on the principal California streams are analyzed. Considerable information in regard to the quality of underground waters has also been obtained.

Kansas.—In cooperation with the state board of health of Kansas, H. N. Parker, assistant hydrographer, has continued the investigation of the quality of waters of the State. The field work, which involved the complete analysis of about 800 samples of water, 300 field assays of water, and the collection of detailed information regarding the waterworks and sewerage systems of practically every municipality in the State, was completed, and the last half of the year was spent in preparation of a report for publication.

Pollution investigations.—A study of the pollution of streams by certain industrial wastes and of methods of preventing the same has been conducted in cooperation with the sanitary research laboratory of the Massachusetts Institute of Technology. E. B. Phelps, assistant hydrographer, has made extensive original research into the character of sulphite-pulp waste liquor and methods of utilizing it, and has submitted his report on that subject.

Industrial uses of water.—A manuscript on the industrial uses of water has been partly prepared by Herman Stabler, assistant engineer. The report considers in detail the different industrial processes in which water is used, the effect of impurities, and various methods of preparing water for industrial consumption.

TECHNOLOGIC BRANCH.

ORGANIZATION.

The organization of this branch in Washington remained the same as at the close of the preceding year, embracing the expert in charge, Joseph A. Holmes; the chief engineer, Herbert M. Wilson, who in the absence of the expert in charge assumes his duties; the editorial assistants; and the general clerical force engaged on the correspondence, records, supplies. shipments, accounts, and bibliography. From the Washington office directions are issued to officers and employees in different parts of the country.

FUELS DIVISION.

The analyzing and testing of the coals, lignites, and other mineral fuels belonging to and required for the use of the United States, in order to determine their fuel value, were continued during the year. The work of the fuels division by sections is summarized as follows:

CHEMICAL SECTION.

The work of the chemical section covered in general all analyses and calorimeter determinations of fuels, including coals used by the Government; the chemistry and physics of the combustion of fuels; the heating value of the various fuels and methods of determining it; and the by-products obtainable in the coking of coals, mainly from public lands. Physical and chemical investigations of the composition of fuels and of the gases evolved at different temperatures and high-temperature measurements of the products of combustion were made by J. K. Clement. A small laboratory was maintained at Washington under the direction of G. O. Spitler for sampling the coals purchased by the government departments in that city.

During the year 1,624 samples of coal were analyzed under the direction of F. M. Stanton, the work involving 24,360 determinations. Calorimeter tests were made on Illinois and Pennsylvania coals to determine their yields in by-products. A laboratory investigation of the losses of moisture and gases by lignites and subbituminous coals in drying was completed. Tests were made by H. C. Porter on the "volatility" or ease of volatilization of different coals, to determine the smoke-producing constituents given off at various temperatures. An investigation of California petroleum was started by Irving C. Allen, 480 samples, covering all the oil fields in the State, being collected. Research work was conducted by J. C. W. Frazer on the composition of coal, involving the use of various solvents for the hydrocarbons, with the object of isolating definite compounds.

A laboratory study of the deterioration of coal in storage was begun, samples of seven representative coals being stored under different conditions. From time to time the amount and composition of gases given off by coal in closed vessels were determined and changes in the character of the coal noted.

The experimental work done at the former chemical laboratories in St. Louis was described in a bulletin (No. 323) that appeared during the year.

STEAM-ENGINEERING SECTION.

Tests were made at Norfolk, on behalf of the Government, to determine the most efficient method of burning certain Virginia and West Virginia coals under boilers. In addition 28 steaming tests with briquets were made on a locomotive and 20 on the U. S. torpedo boat *Biddle*. In cooperation with the Navy Department a test of briquets under service conditions was made on the battle ship *Connecticut*.

During the year the results of a study of 400 steaming tests made at St. Louis were published in a bulletin (No. 325) and the results of a special investigation of drafts were prepared for publication. A report dealing with experiments in heat transmission is in preparation.

The work of the steam-engineering section was under the general direction of D. T. Randall. W. T. Ray conducted investigations on the combustion of fuels in different types of furnaces.

PRODUCER-GAS SECTION.

About 1,251 tests were made in the liquid-fuel investigations, including the effect of various adjustments of the engines on their efficiency, the comparison of gasoline as a power producer with denatured alcohol, and the results of diluting the fuels.

Producer-gas tests, numbering 7, involving 55,965 observations, were made by the close of November, when the gas producer and engines were dismantled and work was concentrated at Washington on computing and tabulating the results.

The results of the gasoline-engine tests at Norfolk have been compiled for publication as a bulletin, and a report dealing with producer-gas tests is in preparation.

Under D. T. Randall, in charge of fuel efficiency tests, C. D. Smith continued in charge of the producer-gas section, and R. M. Strong was engaged on investigations of liquid fuels.

INSPECTION AND SAMPLING SECTION.

The inspection and sampling section has been under the supervision of J. S. Burrows. Its work comprised the collection of mine and car samples of fuels shipped to the testing plants, and also the sampling of coals purchased by various departments of the Government, 966 samples being collected from deliveries to different government buildings in Washington, D. C., and 553 samples being received from various branches of the government service in different parts of the country.

A report on the mine sampling and analysis of the coals tested at Norfolk has been submitted for publication. A bulletin (No. 339) on the purchase of coal under government and commercial specifications on the basis of its heating value was published during the year.

SMOKE-ABATEMENT SECTION.

Supplementing the work of the steam-engineering section, H. W. Weeks, of the smoke-abatement section, under the direction of D. T. Randall, compiled data on the methods and appliances used at more than 500 power plants, in nine States, where bituminous coals were burned under boilers without smoke, the main purpose of the inquiry being to procure a basis for better practice at government plants. The information gathered has been tabulated for publication. A preliminary statement (Bulletin 334) dealing with the smoke problem and the essentials of smokeless combustion was published during the year.

COKING AND WASHERY SECTIONS.

The coking section at Denver continued under the direction of A. W. Belden, and the washery section, also at Denver, under that of G. R. Delamater. During the fiscal year 57 coking tests and 67 washery tests were completed, the samples being taken from coal seams on or adjacent to public lands of the United States. The tests were made with a view to determining the improvement in quality to be obtained by washing and the possibility of making satisfactory coke from particular coals, or from mixtures of different coals.

During the year the results of washing and coking tests of coal and cupola tests of coke made by the fuel-testing plant at St. Louis were published in a bulletin (No. 336).

BRIQUET SECTION.

The work of the briquet section, under the charge of C. T. Malcolmson, was conducted at the Norfolk fuel-testing plant. About 850 tons of briquets were made, of which 460 tons were for tests on naval vessels, 320 tons for tests on locomotives, and 70 tons for the steam-engineering section. Absorption, specific gravity, tumbler, and weathering tests of the briquets have been made; also flowing tests on binders and tests of oils by distillation.

A discussion of the comparative merits of various substances used as binders was published in Bulletin 343. Another bulletin giving details of manufacture and the results of chemical and physical tests of the briquets made at Norfolk is in preparation. The results of steaming tests with briquets will be published separately.

COAL WASTE AND MINE EXPLOSIVES SECTION.

Investigations designed to prevent waste in the development of the nation's fuel supplies and to lessen danger to the miner from explosions of gas or dust were made under the direction of Clarence Hall. During the year Mr. Hall visited the Darr and Naomi mines in Pennsylvania, the Monongah mine in West Virginia, and the Yolande mine in Alabama, where there had been serious explosions, to get at first hand all available data on the conditions existing before the disasters, the exact manner in which the explosions were propagated, and the results of the explosions. He also visited the Shoneberger mine near Pittsburg while it was on fire.

As part of its work this section analyzed samples of black powder and dynamite for the United States Reclamation Service; it also analyzed dynamite and exploders and tested blasting machines and electric fuse wires for the Isthmian Canal Commission, besides inspecting at frequent intervals the plants at which the explosives used by the commission are manufactured. Various other analyses of explosives were made.

A preliminary statistical report on coal-mine accidents was issued as a bulletin (No. 333).

STRUCTURAL-MATERIALS DIVISION.

Investigations of structural materials belonging to and used by the United States, such as stones, clays, cements, etc., were continued during the year at the structural-materials testing laboratories in Forest Park, St. Louis, Mo. The work was directly under the care of Richard L. Humphrey, engineer in charge of the division, who had the assistance of a corps of engineers, chemists, geologists, and others.

LABORATORY WORK.

The following is a résumé of the operations of the division:

Summary of operations of the structural-materials division.

Section.	Test pieces.	
	Made.	Tested.
Constituent materials	3,915	8,081
Beam	1,104	2,764
Block	419	716
Permeability	1,964	1,866
Shear	97	82

In addition to the above-enumerated tests the following analyses were made in the chemical section:

Steel	2,011
Cement	1,113
Rock	38
Wire screen	31
Miscellaneous	355

Also analyses of water, cement, sand, etc., and 631 determinations of mortars, cinders, steel, cements, lime, and rocks were made for the United States Reclamation Service.

In all 3,548 analyses and about 25,000 determinations were made.

All the laboratory work undertaken was done on a basis of cooperation with the ordnance-testing laboratory at Watertown, Mass., so that duplication might be avoided. No important changes in the equipment of the laboratories were made during the year.

FIELD WORK.

A preliminary examination of materials about Denver, St. Louis, and San Francisco, as well as a detailed study of the structural materials about Portland, Oreg., and Tacoma and Seattle, Wash., was made by N. H. Darton, geologist, who was assigned to the technologic branch. Several tons of sand, gravel, and broken rock were obtained at Portland and Seattle and shipped to St. Louis to be tested for their value in concrete.

Other field work was done in Illinois, Iowa, and Missouri, and samples of stone and sand were shipped to St. Louis from several localities.

PUBLICATIONS.

A bulletin (No. 324) on the San Francisco earthquake and fire; another (No. 329) describing the organization, equipment, and operation of the structural-materials laboratories; a third (No. 331) on Portland cement mortars and their constituent materials; and a fourth (No. 344) treating of the strength of concrete beams have been published during the year. A report describing fire-resisting tests of various building materials has been submitted for publication.

SPECIAL INVESTIGATIONS.

The following special problems were studied: The occurrence and distribution of workable peat deposits, by C. A. Davis, peat expert; the origin of coal, by C. D. White, geologist; microscopic investigations of coal, by R. Thiessen, assistant chemist; and the occurrence of gases in coal, by R. T. Chamberlin, assistant geologist.

Mr. Davis visited a number of peat bogs in the Atlantic States.

Mr. White completed a study of the relative importance of oxygen and ash in coal as affecting its heating value, based on the large number of ultimate analyses of coal and lignite made by the fuels division, and prepared a report on his findings. Mr. White also took up the experimental treatment of the lignites of North Dakota and eastern Montana, in order to develop methods of handling that will give quantitative as well as microstructural data. Several related coals and some living woods were included in these studies for the sake of comparison.

Mr. Chamberlin, in connection with his work, visited the Monongah mine, in West Virginia, and the Naomi and Darr mines, in Pennsylvania, after disastrous explosions, and collected samples of mine air, after damp, gas, dust, and coal, which he analyzed. Comparative studies on the mine-dust samples, charred and uncharred, old dust from the main entries, and fresh dust obtained near the coal face have been in progress.

PUBLICATION BRANCH.

BOOK-PUBLICATION DIVISION.

SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 1 monograph, 2 professional papers, 30 bulletins (1 of which was also published in 7 separate chapters) and 13 advance chapters from one other bulletin, 22 water-supply papers, 1 annual report on mineral resources for 1906 (also published in 45 separate chapters), 5 advance chapters from the annual report on mineral resources for 1907, and 9 geologic folios. These publications were the Twenty-eighth Annual

Report; Monograph XLIX; Professional Papers 53 and 56; Bulletins 304, 309, 311, 313, 316 (volume and 7 separates), 317 to 337, 339, 13 separates from 340, and 342 to 344; Water-Supply Papers 195, 197, 198, 199, and 201 to 218; Mineral Resources for 1906 (volume and 45 separate pamphlets) and 5 separate chapters from Mineral Resources for 1907; geologic folios 151 to 159, inclusive. Summaries of these publications are given on pages 11–20 of this report. They comprise 10,149 pages, those of the last fiscal year covering 14,875 pages. In addition to the publications of the regular classes many circulars and pamphlets, most of them relating to administration, were published.

During the year 20,691 pages of manuscript were prepared for printing, and proof sheets for 10,827 final printed pages were read and corrected, this work involving the handling of 4,479 galley and 16,140 page proofs. The corresponding figures for last year were 26,912 manuscript pages, 16,833 final printed pages, 7,112 galley proofs, and 28,018 page proofs.

The make-up was prepared for 369 plates, the proofs of which were also read, as against 661 plates so prepared last year.

Indexes were prepared for 39 publications, covering 7,538 pages, the corresponding figures for last year being 67 publications and 12,167 pages.

Six persons have been employed in this section for most of the year. The amount of work recorded is considerably less than that reported last year, but material assistance was rendered at different times in reorganizing the work of the section of distribution.

SECTION OF ILLUSTRATIONS.

Illustrations were prepared for 1 annual report, 3 professional papers, 25 bulletins, 7 water-supply papers, 2 volumes of mineral resources, and 1 handbook for geologists. These illustrations consisted of 175 maps, 713 sections and drawings, 3,325 paleontologic drawings, 586 photographs (retouched), and 144 miscellaneous illustrations.

At the close of the year material for the illustration of 28 reports was in hand, part of which has already been prepared. The committee on illustrations has rejected during the year 433 illustrations, or 8 per cent of the number submitted to the publication division.

Proofs to the number of 1,858 were received and compared critically. Not only have many proofs been carried up to the fourth revise, but considerable preliminary proof reading of lithographic map work has been done to expedite the completion of the lithographs by the contractors. The examination of the printed editions of 403 plate inserts delivered by the various contractors at the Government

Printing Office resulted in the rejection of 2,007 copies, and their reprinting was ordered by the Public Printer.

During the year 182 electrotypes were furnished to outside applicants not connected with this Survey, and 45 cuts were reused in various reports.

SECTION OF GEOLOGIC MAPS.

The number of folios published and prepared for publication by this section was less than usual this year, and the drafting force was employed part of the time in compiling data for the geologic map of North America and preparing maps for other geologic reports. At the beginning of the year 15 folios were on file or in course of publication, and 4 were transmitted to the section for publication during the year. Of these 9 have been issued. (See pp. 19–20.)

On June 30, 1908, but one folio, Mercersburg-Chambersburg, Pa., was on file and 9 were in course of engraving and publication: Aberdeen-Redfield, S. Dak.; Accident-Grantsville, Md.-Pa.; Bellefourche, S. Dak.; El Paso, Tex.; Franklin Furnace, N. J.; Philadelphia, Pa.-N. J.; Santa Cruz, Cal.; Trenton, N. J.-Pa.; Watkins Glen-Catatonk, N. Y.

SECTION OF TOPOGRAPHIC MAPS.

A year ago the editor of topographic maps reported 69 new topographic atlas sheets and special maps which had not yet been put into the hands of the engravers and 34 in process of engraving. The corresponding figures on June 30, 1908, were 54 and 37. The accessions during the year numbered 81 maps, and the withdrawals 3 maps; 90 maps were published.

Manuscripts edited, including verification or correction of all geographic names: Atlas sheets and special maps, 77; corrections, 158 maps. Proof read: New topographic atlas sheets and special maps, 90; corrections, 158. During the year the manuscripts of 179 map illustrations to be included in 33 volumes, including 2 Senate documents, were examined and edited. Five persons were engaged in the work of this section during the entire year.

SECTION OF DISTRIBUTION.

There were delivered to the section of distribution during the year 127 new books, 9 folios, 87 new maps, 127 reprints of maps, and 15 special maps, a total of 365; the totals of all editions being 332,523 books, 42,231 folios, and 534,477 maps; grand total, 909,231.

During the year 333,705 volumes, 39,389 folios, and 474,868 maps (including 369,521 sold), a total of 847,962, were distributed.

The total amount received and turned into the Treasury as a result of sales of publications was $17,013.56, a decrease of $1,619.75 from the amount received during the year 1906–7.

During the year 76,670 letters were received, answered, and filed, being 7,210 fewer than for the preceding year.

DIVISION OF ENGRAVING AND PRINTING.

MAPS, FOLIOS, AND ILLUSTRATIONS.

At the beginning of the year 103 atlas sheets and special maps were on hand for publication, 34 of which were partly engraved. Of these, 3 were afterward withdrawn, leaving 100. The accessions during the year (comprising new maps, reductions, and combinations) numbered 81 maps. The status of these 181 maps on June 30, 1908, was as follows:

Published during the year or in press at its close (double sheets counted one)	90
In process of engraving	37
Not taken up	54

Besides the engraving of new maps, corrections were made on the copperplates of 158 maps hitherto published. Editions of 214 maps were printed and delivered to the map room. Of these, 87 were new and 127 were reprints or new editions.

Nine geologic folios were published and 42,231 copies printed and delivered. Nine other geologic folios were partly completed at the close of the year.

Under contracts with the Government Printing Office, illustrations were printed for the following publications: Professional Papers United States Geological Survey, Nos. 55, 60, 62, 63; Bulletins United States Geological Survey, Nos. 318, 320, 321, 324, 335, 338; congressional documents, Sixtieth Congress, first session—Senate Documents Nos. 151 and 325, Senate Report No. 580, and House Document No. 719. For the Government Printing Office, also, maps of 9 bird reservations, 2 national monuments, and 1 national park were reproduced and printed. For the Forest Service maps of 27 national forests were reproduced, printed, and delivered. This work for other branches of the Government amounted to $46,800.90, and the division was reimbursed by transfer of credit on the books of the United States Treasury.

Of miscellaneous matter of all kinds the total number of copies printed was over two million and required over seven million printings. The total number of copies printed of maps, folios, and miscellaneous matter was 2,824,796, requiring over eleven million impressions. There were also 299 transfer impressions made and sent to contracting printers.

INSTRUMENT SHOP.

The work of the instrument shop consisted in overhauling and repairing surveying, drafting, and engraving instruments, and in making copperplates and electrotypes. More than 1,700 repairs were made to instruments, and 273 new copperplates and 35 electrotypes were finished.

PHOTOGRAPHIC LABORATORY.

The output of the laboratory included 14,194 negatives, of which 13,087 were glass and 1,107 were paper; 42,763 prints, of which 11,650 were map prints and 31,113 were mat prints; and 1,411 lantern slides.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

Correspondence, records, appointments, supplies, and shipments.—The total amount of work performed in this section was considerably greater than that for the fiscal year ending June 30, 1907. The scope of the work of the section has been enlarged (1) by the appointment of a purchasing clerk, whose duty it is to make arrangements for purchases of all material procured at Washington in the open market, and to issue the orders therefor; (2) by the establishment of a " follow-up " system on all correspondence recorded in the section; (3) by the recording of a greater proportion of the letters received; (4) by the establishment in the section of the sales offices for local cash sales of Survey publications; (5) by the establishment of a system of cost keeping; and (6) by the increased number of letters filed. Moreover, the general growth of the Survey manifests itself at every desk in this section.

Mails, files, and records.—During the year 107,283 pieces of mail were received, an increase of 2 per cent over the number for the previous fiscal year. Of this mail, 20,218 pieces, an increase of more than 10 per cent over the number for 1907, contained remittances for sale publications of the Survey.

The recording and filing of correspondence required the services of three clerks throughout the greater part of the year. The number of letters mailed through the section was 66,860, of which 17,509 were registered.

Personnel.—In the roster of secretarial appointments 916 changes were made and recorded during the year, as compared with 1,002 in the previous year. Of these changes 335 were new appointments, 147 separations (4 by death), 247 promotions, and 9 reductions. The remaining 178 changes were such as not to affect the total number of employees or the pay rolls, and included extensions of limited appointments, changes of title, changes from annual to per diem rating or the reverse, the designation of disbursing agents, etc. The decrease in the number of changes recorded is accounted for by the change in the department method of making probationary appointments absolute. There are now on the rolls of the Survey 840 names, an increase of 188, or 28.8 per cent.

An average of 1,250 applications for leave were handled per month, or 15,000 for the year. These covered 11,331 days of annual leave and 2,428½ days of sick leave, being 55 per cent of the amount of annual leave and 12 per cent of the amount of sick leave which it is permissible to grant under the law; also 8,508½ days of leave without pay. The above figures of leave without pay do not cover the transfers to state pay rolls, nor do they include 64 indefinite furloughs, which were made in December for employees of the technologic branch.

Property accountability.—During the year the system of property accountability by custodians for various branches and divisions was continued and, in addition, a custodian of office property was designated to make an inventory of all nonexpendable property in Washington. This inventory was nearly completed at the end of the year.

The amount derived from the sale at public auction of property examined by inspectors and found unserviceable was $1,418.77. During the preceding fiscal year it was $2,946.29.

Express and freight.—During the year 4,750 pieces of express and freight, of which 1,092 pieces were outgoing and 3,658 pieces were received, were handled by the shipping clerk, who also checked 641 freight and express accounts.

Purchase and distribution of supplies.—The present system concentrates in this section all operations connected with purchases in Washington, such as procuring bids, issuing orders, and preparing vouchers, and requires the services of three persons during most of the time. During the year 2,220 requisitions were handled, which involved the drawing of 2,360 orders. Under the system of drawing the order and preparing the voucher at one operation, the number of vouchers passed was the same as that of orders drawn.

Stationery.—In the stationery room the services of three men are required for handling mails, delivering supplies throughout the office and packing and shipping them to the field parties, and keeping an account of the charges for stationery supplies. During the year 8,913 requisitions for blanks, blank books, and miscellaneous supplies were filled from stock on hand and 447 requisitions were drawn on the department for supplies. In addition to this work, 613 requisitions for printing were made on the department, and 397 requisitions for furniture and supplies.

Administrative bookkeeper.—All transactions of the Survey requiring administrative examination and check are handled by the administrative bookkeeper, who acts in the dual capacity of audit clerk and bookkeeper. A satisfactory system of accounts and double-entry bookkeeping was adopted at the beginning of the year, the net results of which are given in the following table of classification of disbursements, the repayments shown in the table on page 91 having been deducted.

Classification of expenditures by the United States Geological Survey for the fiscal year ended June 30, 1908.

Appropriation.	Salaries and wages.	Traveling expenses.	Office furniture and fixtures.	Telegrams and telephones.	Instruments.	Camp outfit.	Subsistence.	Forage.	Erection of testing plants.	Operation of testing plants.
Salaries, statutory	$64,503.45									
Skilled laborers, etc	19,964.45									
Gaging streams, etc	76,335.05	$5,829.01	$565.39	$271.05	$1,330.43	$571.10	$8,277.17	$548.68		
Paleontologic researches	8,883.75	484.86	3.73	1.20	.60	16.05	305.00	221.42		
Chemical and physical researches	17,103.59	23.24	73.40	.30		67.47	13.35			
Preparation of illustrations	16,862.32	2.25	73.83	24.91	8.41		.50			
Report on mineral resources	57,332.76	5,182.41	1,969.94	447.52	185.28	43.94	2,375.90	13.20		
Topographic surveys	176,752.91	24,494.92	719.40	360.47	5,717.13	13,145.73	46,990.02	17,002.40		
Geologic surveys	145,881.87	14,345.72	1,764.36	232.16	2,923.60	7.414.11	11,619.77	4,113.05		
Mineral resources of Alaska	41,181.84	14,920.62	1,142.96	91.57	262.39	6.271.37	7,523.12	2,329.14		
Geologic maps of United States	65,871.17	50.55	693.44	19.23	45.90		105.60			
Surveying forest reserves	60,628.10	3,895.43	244.20	56.78	1,653.38	2,101.80	11,331.70	8,252.62		
Testing fuel	176,196.91	10,306.40	1,106.53	352.45	1,065.62	389.80	11,031.57	1,366.75	$20,825.29	$12,357.27
Testing structural materials	64,016.22	3,567.36	241.08	579.87	962.68	72.85	2,402.94	3.10	15,127.16	3.034.35
	991.514.39	83,102.77	8,598.26	2,437.51	14,155.42	30,094.22	101,976.64	33,850.36	35,952.45	15,391.62

Appropriation.	Stationery supplies.	Library.	Rent.	Transportation of property.	Photographic material.	Engraving and printing material.	Chemical and physical laboratory material.	Drawing material.	Control material.	Total.
Salaries, statutory										$64,503.45
Skilled laborers, etc										19,964.45
Gaging streams, etc	$1,206.02		$1,120.00	$1,092.71	$601.60		$1,339.34	$48.68		99,136.23
Paleontologic researches	14.00			16.00	20.40		.35			9,967.36
Chemical and physical researches	35.02			30.13	9.96		2,126.13	2.50		19,485.09
Preparation of illustrations	115.03			4.00		$636.27		65.65		17,793.17
Report on mineral resources	1,892.68		512.43	315.08	68.95		796.78	11.35		71,148.22
Books for library	12.76	$1,734.98		26.99						1,774.73
Rent of basement			1,500.00							1,500.00
Rent of office rooms			3,000.00							3,000.00
Topographic surveys	3,891.95		264.07	5,201.03	1,892.31		15.40	524.43	$2,899.11	299,871.28
Geologic surveys	1,553.81		6.00	1,950.23	3,884.86		471.55	344.14		196,506.23
Mineral resources of Alaska	507.67		68.00	4,378.55	662.81		303.10	63.94		79,707.08
Geologic maps of United States	208.56		8.00	75.15		31,791.16				98,868.76
Surveying forest reserves	7,062.70		24.80	730.75	1,075.23		9.26	418.40	49.70	97,534.85
Testing fuel	813.50		97.54	2,708.30	1,093.78		7,998.13	71.50		247,781.34
Testing structural materials	537.06		257.20	3,437.10	517.72		4,147.43	113.08		99,017.20
	17,850.76	1,734.98	6,858.04	19,966.02	9,827.62	32,427.43	17,207.47	1,663.67	2,948.81	1,427,558.44

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ended June 30, 1908.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director	$35,340.00	....	$35,340.00	$34,603.46	$736.54
Salaries, scientific assistants	29,900.00	....	29,900.00	29,899.99	.01
Skilled laborers, etc	20,000.00	....	20,000.00	19,964.45	35.55
Gaging streams, etc	100,000.00	$28,270.73	128,270.73	127,406.96	863.77
Paleontologic researches	10,000.00	3.42	10,003.42	9,970.78	32.64
Chemical and physical researches	20,000.00	4.35	20,004.35	19,489.44	514.91
Preparation of illustrations	18,280.00	10,655.00	28,935.00	28,448.17	486.83
Report on mineral resources	75,000.00	1,147.42	76,147.42	72,295.64	3,851.78
Books for library	2,000.00	....	2,000.00	1,774.73	225.27
Rent of basement	1,500.00	....	1,500.00	1,500.00	....
Rent of office rooms	3,000.00	....	3,000.00	3,000.00	....
Topographic surveys	300,000.00	16,418.19	316,418.19	316,289.47	128.72
Geologic surveys	200,000.00	9,022.46	209,022.46	205,527.69	3,494.77
Mineral resources of Alaska	80,000.00	107.34	80,107.34	79,814.42	292.92
Geologic maps of United States	100,000.00	46,802.74	146,802.74	145,671.50	1,131.24
Surveying forest reserves	100,000.00	167.40	100,167.40	97,702.25	2,465.15
Testing fuel	250,000.00	2,806.95	252,806.95	250,588.29	2,218.66
Testing structural materials	100,000.00	945.84	100,945.84	99,963.04	982.80
	1,445,020.00	116,351.84	1,561,371.84	1,543,910.28	17,461.56

LIBRARY.

Accessions.—Inadequate room in the library has forced the continuance of the policy of discarding books to make room for accessions. During the twenty-six years of its existence the library has acquired, by exchange and otherwise, many valuable works that are not wholly of geologic interest. Although these would not be out of place here if shelf room were ample, they have been removed to make room for works more frequently consulted. More to be regretted was the necessity of discarding, on account of their large size, a number of periodicals, including some mining journals; but the discarded books are transferred to the Library of Congress, where they are cared for and made available for reference.

In the Library of Congress the section of geology is unimportant, this subject being left for the Geological Survey's library to cover. The Survey library is therefore coming to be used more and more by geologic students and writers, both resident in Washington and visiting. The readers in the library this year numbered 8,580, and the books loaned, not including those consulted in the library, 9,279.

Owing to the more rigid scrutiny of accessions the increase during the year was less than usual. About 10,000 items, including books, pamphlets, periodicals, and maps, were added. Notable among these are:

Journal of the Royal Microscopical Society of London, 1878–1898. 21 volumes.
Abhandlungen der Naturforschenden Gesellschaft, Halle, 1853–1906. 22 volumes.
Mitteilungen der Ungarischen Geologischen Gesellschaft, 1872–1882.

During the year 1,990 complete volumes were added to the accessions record, which on June 30, 1908, shows the library to contain 62,174 volumes. This number is exclusive of the 3,894 numbered volumes that have been transferred to the Library of Congress.

As in past years, the exchange list has been supervised in the library. All publications of the Survey so far as issued have been distributed to its correspondents, from whom a large proportion of the most valuable additions to the library are received, including the transactions of all the known geologic societies of the world, most of the geologic reports issued by governments, many important private monographs, and other publications.

The appropriation of $2,000 for purchase of books enables the library to acquire about 70 periodicals, the principal new publications of geologic interest, and occasionally to add, through purchase from second-hand dealers, some rare out-of-print works long needed.

Catalogue.—About one-sixth of the contents of the library have now been completely catalogued, and printed entries therefor have been incorporated in the card catalogue. All the rest are briefly entered in the library records, and, being classified on the shelves, are available when called for. The complete cataloguing is continued as rapidly as possible, 6,960 volumes having been catalogued and shelf-listed this year.

Practically all the catalogue entries of geologic books (except those of copyrighted books) that are printed on cards for sale by the Library of Congress are supplied by the Survey library, 1,106 of these entries having been furnished during the last year.

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The map catalogue includes about 700 entries, principally of maps published in the United States by the various state surveys, by the Government of Great Britain, and by the geological surveys of Norway and Sweden. It includes also folios of the Geologic Atlas of the United States.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THIRTIETH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1909

WASHINGTON
GOVERNMENT PRINTING OFFICE
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THIRTIETH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1908–9 comprised items amounting to $1,590,680. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the various branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES OF THE WORK.

PROGRESS IN LAND CLASSIFICATION.

Land classification in aid of the administration of the public lands has been for several years and is now actively prosecuted by the Geological Survey, and reports setting forth in detail the mineral or nonmineral character of public lands of which the Survey has made actual field examination are being transmitted to the General Land Office.

Another and more recent line of activity in land classification is the segregation of nonirrigable lands under the terms of the enlarged homestead act of February 19, 1909. The recommendations of the Geological Survey on which the Secretary of the Interior bases his designations have not depended on surveys made for this specific purpose, but on data collected through a period of many years by federal geologists and engineers. The existence of this information whereby, within the few months since the enactment of the law, the Secretary has been able to designate areas in 9 States and Territories aggregating 162,000,000 acres, is in itself a forceful argument for a land classification that is complete and authoritative.

This classification of the public lands serves two important ends, one administrative, the other legislative, and it is believed that both were contemplated by Congress at the time of the creation of the Survey. The classification of the public domain and the investigation of its resources not only facilitate the work of fulfilling the requirements of existing law, but also furnish Congress with data on which to base new legislation and particularly aid in the development in the land laws of the principle of relative worth, which is that the land must be so disposed of or so reserved as to insure utilization for the purposes for which it is most valuable. No principle is more fundamental to real conservation and at the same time more beneficial to the mining and other industries than this of giving preference to the highest possible use for the public lands. The earliest land laws, those of a century ago, provided for the reservation of mineral lands from disposal for other purposes, and the present coal-land law expresses this principle of relative worth by giving gold, silver, and copper deposits priority over the coal, and coal in turn preference over agricultural values. With classification data at hand the principle of relative worth can be further developed. Wherever the different values conflict the higher use should prevail. On the other hand, wherever the different values can be separated that separation by appropriate legislation is at once the easiest and best solution of the problem; for instance, the surface rights may be separated from the right to mine underlying beds of coal. The first step in this direction was taken in March of this year in the passage of the Mondell Act for the protection of the surface rights of entrymen, whereby the homeseeker may secure all for which he made entry—all that he swears he is getting—while the coal beneath his tillable land is reserved to the nation for future disposal. Land legislation of the future should strengthen this principle of relative worth where it already exists in law and introduce it further in all new legislation.

As an instance where thorough knowledge of the character of a special public-land tract with its strategic relation to the hydrography of the region enabled the Department of the Interior to aid Congress may be cited the act of February 20, 1909, reserving for public use eight sections of waste land in southern California. The law provides that this land shall be used for the diversion of flood waters into underground storage, thereby replenishing the supply of underground waters in the San Bernardino Valley. While apparently of only local scope, the principle established in this legislation is really of great importance as providing a course of action that will be found adaptable elsewhere in securing effective conservation of flood waters.

Hydrographic and topographic surveys which are now in progress under the instructions of the Secretary of the Interior have as their purpose the collection of information that may be presented to Congress in aid of legislation looking toward the best utilization of the water powers of the public domain. The information available as to the undeveloped water powers of the United States is far from complete, but to a very large extent it represents the work of the water-resources and topographic branches of the Geological Survey. With these earlier records and surveys as a basis the Survey is now actively engaged in examining power sites to which the Government still retains the title. Those who are making this study of the water-power problem fully realize that economical utilization of these natural stores of energy requires their development on a large scale, with the investment of capital in large amounts. The day is past for inexpensive developments where only the minimum flow is used and that inefficiently. With the present demand for unfailing power in mind, we need not look far into the future to see storage as a universal factor in water-power development. Utilization of the undeveloped water powers on the public domain, therefore, involves either government development or long-time leases of these power sites to strong financial interests, and in the latter event the law must provide for effective government control which will insure that the profit to the capital accomplishing the development can not impose unjust burdens on the users of the power, whether the utilization be for transportation, city lighting, or motive power.

The purpose of the coal land classification surveys is twofold—to expedite complete restoration to agricultural entry of land thus determined to be barren of coal although included in the general withdrawals, and to promote the utilization of the coal lands, which to-day represent the greatest natural resource to which the people retain an unquestioned title. The geologic investigations of the last three field seasons have not only furnished a knowledge of the quantity and quality of the coal on the public domain, but have rendered possible the present policy of obtaining coal prices for coal lands. The General Land Office now depends on the Geological Survey to furnish detailed valuations for every 40-acre tract of coal land that is placed on the market. It is conceded that this policy of basing the price on the quantity and quality of the article sold will discourage purchase by speculators, but there is no reason to believe that the government valuation will impede the disposition of the coal deposits for purposes of utilization. The real development of the West will be promoted, not retarded. The situation is clearly viewed by the editor of a western mining journal, who has recently stated that this increase in valuation "can produce but one result—the lands will be sold only as they are actually needed for mining purposes. This should reduce the danger of monopoly, without promoting overproduction and wasteful competition. In the end it should give future generations cheaper coal. The unearned increment will go in part to the nation rather than to individuals." If a scientific classification and adequate valuation of the coal lands will accomplish all this, what more can be asked?

The scale on which this work is being prosecuted is indicated by the record of the three and a half months following the adoption of the revised scheme of valuation; in this period, which includes July of the next fiscal year, the recommendations to the General Land Office resulted in the release to agricultural entry of approximately 6,875,000 acres of noncoal land in Colorado, Wyoming, and Montana, and placed selling prices on nearly 1,500,000 acres of coal land with an aggregate valuation of nearly $94,000,000, which is an average advance of more than 200 per cent over the minimum prices fixed by law. Under the regulations setting forth the plan of valuation of government coal land the price is determined on the basis of estimated tonnage, and the unit rate varies with the quality of the coal, ranging from half a cent to 3 cents a ton for deposits within 15 miles of a railroad. The prices thus calculated range from 5 to 30 per cent of the usual royalty paid in the West, which is uniform without regard to the quality of the coal, yet this conservative valuation will more than double the average price of public coal lands, not to mention the fact that this policy of land classification has stopped the illegal disposal of coal lands at even less than the minimum coal price. Exceptional cases like one in Wyoming might be cited where the average price based on tonnage represents a fifteenfold increase over the old minimum price. Sales are being made at the new prices, and the reports from one land office already indicate a greater activity in coal lands priced at $25 and $50 an acre than existed a few years ago when they were sold at the minimum price of $10 and $20.

In the western oil fields the classification work by the Survey has resulted in protecting the oil man from the agricultural claimant, and with a better law the reports of the Survey geologists would also protect the oil prospector from the devices of the gypsum entryman. The next move on the part of the Federal Government in its capacity as the present owner of a large acreage of oil lands should be to protect the oil industry from itself by preventing injury to future productiveness through reckless drilling and by discouraging production in advance of possible disposal.

ORGANIZATION OF LAND-CLASSIFICATION BOARD.

When the Survey undertook the classification of the public lands in the West, both field examination and actual classification were made by the field geologists. After several years' experience it was found that the resulting classifications were not consistent among themselves, and the necessity was recognized for a uniform standard which should consistently conform to the policy of the Department. Also the classification work was extended to cover not only coal lands, but oil and gas and phosphate lands, enlarged homestead entries, and water-power sites, and the proper coordination of all this work became important. Furthermore, the records had become cumbersome and complicated, so that it was necessary to provide a common custodian for them. These considerations led to the organization of a land-classification board in December, 1908.

This board consists of a general advisory section and such classification sections as may be established from time to time to deal with any particular class of public lands. The chairman of the general board is also chairman of the several classification sections and is in charge of the office force and records.

The advisory board, which is charged with consideration of questions of policy and approval of standards only, consists of the chairman and the chiefs of sections and branches in charge of the field work on which the classification of the board are based. Its personnel is as follows: A. C. Veatch, chairman; C. W. Hayes, chief geologist; M. O. Leighton, chief hydrographer; M. R. Campbell, chief of section of economic geology of fuels; and Waldemar Lindgren, chief of section of metalliferous ores.

The actual classifications are made by sections composed of three members, the chairman of the board and two members specially qualified in each case to deal with the questions involved in the classification. These sections are at present constituted as follows:

Coal: C. A. Fisher and G. H. Ashley.
Oil: M. J. Munn and Robert Anderson.
Phosphate: F. B. Van Horn and E. O. Ulrich.
Metalliferous deposits: H. D. McCaskey and F. L. Ransome.
Nonirrigable lands: W. C. Mendenhall and J. C. Hoyt.

When the board was created the records of withdrawals and classifications were incomplete and involved. The increasing complexity of the work demanded readily accessible records, which should show completely and accurately every action taken in regard to any tract of land. Such a record is now in course of preparation. With the hearty and efficient cooperation of the General Land Office the complete records on file in that office are being checked with the records of the Survey, and it is expected that before the end of the next fiscal year the township card catalogue, showing every action taken with regard to any land in each township in the public-land States, will be completed.

With regard to new work in coal, phosphate, oil, enlarged homesteads, and power sites the plan has been adopted of keeping ledger accounts of each class of work, from which the total acreage, classified by months and by States, and in case of coal lands the relation between the prices as fixed by law, can be expeditiously determined. These ledger accounts will be extended to the past work as rapidly as possible, and when completed will give detailed statistics, correct to date and immediately available. As a card record, though necessary to preserve all the details regarding actions affecting individual tracts, is nothing more than a jumble of numbers which must be plotted on maps to give an idea of relative areas and locations, a system of small-scale graphic index State maps has been installed, which are brought up to date the first of each month. These graphic records have proved of great value and have been freely used by the Department.

INVESTIGATION OF WATER RESOURCES.

Investigation of the water resources of the United States, together with a study of the uses to which they may best be adapted, has been continued by the water-resources branch along the general lines previously laid down. The work and its significance have, however, broadened materially. Many of those who formerly expressed doubt concerning its utility now realize that it is indispensable to the intelligent development of the country's water resources, whether that development be for power, navigation, irrigation, flood control, or domestic water supply. It requires no technical training to appreciate the necessity for finding out what and how much water is available for use, where it is, and how it can best be directed in the course of profitable development and utilization.

During the earlier period almost the only real appreciation of the work shown by even well-informed people was that in connection with its utility in the arid country. To-day the arid West has no monopoly of general interest in water problems. Inland navigation is enthusiastically advocated by the people at large, who have developed a great unanimity with reference to general policy in this matter. But little less interest is shown in the matter of water power, which, by reason of improvements in electric transmission, has been changed in its position in the public economy from a purely local agent to a great public utility. It is therefore no longer necessary to argue that the investigation of water resources is a necessity, and it is becoming more and more apparent that such a study constitutes one continuous problem, which is not confined within state lines and can not be divided up into districts, and that the work therefore, if it is to be efficiently performed, must be performed by the Federal Government.

The timeliness of the work that has been done and the results that have accumulated in past years were well illustrated in the investigations of the National Conservation Commission. All inquiries of the commission concerning stream flow, water power, floods, and underground waters, as well as the greater number of those concerning irrigation and drainage, were referred to the water-resources branch of the Survey. To have procured the information anew would have taken several years and necessitated the expenditure of a very large amount of money. By reason of its previous work, however, the water-resources branch was able to give comprehensive statements and reports on the topics concerning which information was desired. The contribution to the conservation report was therefore a mere rounding up of material which was available for publication through the regular channels and which would have been so published had not this opportunity for a field of larger usefulness presented itself; in other words, this contribution was neither more nor less than a progress report.

The scope of the water-resources investigations has recently proved to be of national significance in two important respects. The first is the necessity for the data gathered in conection with the administration of the enlarged homestead act, passed by the Sixtieth Congress. This act authorizes the Secretary of the Interior to open to entry, in homesteads of 320 acres, all public lands that are nonirrigable or impracticable of irrigation except with the expenditure of a disproportionate amount of money. It is obvious that the proper administration of this act requires at the outset a knowledge of the available water supplies. Without such information the act is practically nonadministrable. The second national feature dependent on these investigations is the temporary withdrawal, under the authority of the President, pending legislative action, of water-power sites along the rivers of the public domain. The extent and value of any water power depend on the amount of water that the stream furnishes. To withdraw from entry power sites on the public domain intelligently would be impossible without definite information, and, were not available data at hand, the propositions for withdrawal would involve a gigantic piece of investigation that could not be finished for a long term of years. It is true that information is lacking regarding a large number of important sites on the public domain, but it is also true that by the aid of the information which the Survey had collected during past years it has been possible to withdraw a large number of power sites immediately, and many more can be withdrawn in the near future, by reason of the fact that partial information is now available and can soon be made practically complete. It is believed by many that the protection and proper administration of the great water-power sites of the public domain constitute one of the most important projects of the present administration. The people are becoming each day more dependent, for their industrial productivity as well as for their comfort and happiness, on the energy available for development and partly developed in our streams. The circumstances present in a clear fashion one convincing line of evidence as to the necessity for carrying this work forward to a purposeful finish.

TOPOGRAPHIC SURVEYS.

The popular appreciation of topographic surveys, as witnessed by the steady increase in sales of the Survey maps, is believed to be indicative of the increased efficiency of the topographers. Other recognition of the high standards attained has come in the calls for the topographers of the Survey to take up similar work in other countries. Not only have members of the topographic branch been detailed to work under the international boundary commissions, on the Porto Rico Irrigation Survey, and for the Isthmian Canal Commission, but Survey topographers have resigned or taken leave of absence to make topographic surveys in Mexico, Honduras, Peru, Africa, and China. The latest and possibly most notable instance of appreciation of the topographic work of this Government has been the request from the Director of the Canadian Geological Survey for the temporary assignment of one or more of the most experienced topographers to be employed by the Canadian Survey in the inauguration of similar topographic work. In Canada one topographer is at present on leave of absence and acting in the capacity of field instructor to several of the Canadian parties.

MINE ACCIDENTS.

Within three months after the appropriation by Congress "for the protection of lives of miners in the Territories and in the district of Alaska, and for conducting investigations as to the causes of mine explosions with a view to increasing safety in mining" (approved May 22, 1908), the mine-accidents division of the technologic branch of the Geological Survey had been organized, a large part of its equipment had been installed in the government buildings on the arsenal tract at Pittsburg, and the investigations into the causes of mine explosions were already under way.

With a view to profiting as far as possible by the experience in other countries, two of the Survey engineers visited the coal-mining regions in England, Scotland, and Wales during August, and one of them extended his investigations through the coal-mining regions of France, Belgium, and Germany during September and October. In addition to this, three of the countries which had done most in reducing the loss of life in mining—Great Britain, Belgium, and Germany—were invited by this Government to send to the United States their most experienced officers in mine-safety work to advise this Survey as to its plans for these investigations. The invitation received favorable action; the three experts came to the United States about the end of August, and after examining the plans and equipment of the mine-experiment station that was being established at Pittsburg, visited a number of the more important coal fields of the country and presented to the Secretary of the Interior a report embodying in condensed form their recommendations looking to greater safety in American coal mines. This report was promptly published and widely distributed throughout the United States to persons interested in the mining industry.

The investigations conducted at the Pittsburg station during the fiscal year have included (*a*) an examination of explosives used in coal mining in the United States; (*b*) an examination into the occurrence of explosive gases and inflammable or explosive dust, and a special examination of those mines in which explosions have occurred during the year; (*c*) an examination of so-called safety lamps used in mines in the United States, and of mine rescue apparatus for use in mines filled with poisonous and explosive gases; (*d*) a study of the conditions under which electricity may be safely used in coal mines where either gas or inflammable dust abounds.

In these investigations the Survey has had throughout the year the hearty cooperation of the miners, mine operators, and state inspectors. It is believed that decided progress has been made in determining the causes and means of preventing such disasters.

The manufacturers of explosives used in coal mining have voluntarily submitted their explosives for testing at the station and have withdrawn from the market a number of explosives that failed to pass these tests. They have also made commendable efforts to increase the safety of their explosives even beyond the requirements of these tests, and have shown a desire to carry out the wishes of the state inspectors and the recommendations of the federal engineers and chemists connected with these investigations.

It is hoped that the maximum in the loss of life in coal mining in the United States has been reached and that hereafter, with the basis for intelligent action furnished by these investigations and with the hearty cooperation of all those interested in mining, there will be a steady yearly decline in the loss of life in this country from explosions. But in view of the fact that more than 85 per cent of the fatalities in our coal mines are due not to explosions, but to other though in many cases related causes, it is important that the scope of the investigation be extended to include all conditions which make for greater safety in mining.

TECHNOLOGIC INVESTIGATIONS FOR THE GOVERNMENT.

During the year the demands on the Geological Survey for special services to other branches of the Government have steadily increased. In connection with the fuel resources of the country there has been a call for information concerning not only the fuel supplies on the public lands but also the fuels for use by different branches of the government service. The larger part of the fuel used by the Government (other than that used on board naval vessels), involving an annual expenditure of more than $5,000,000, is now purchased under specifications prepared by the Survey, and this coal is sampled and tested by members of the Survey. The supplies of coal for use on government vessels are to an increasingly large extent being purchased from mines which have been examined and whose coals have been tested by the Survey. The supplies of crude petroleum and other mineral fuels for the government service are also being subjected to similar examination.

In connection with the building and engineering construction work done by the Government, the materials to be used are now being generally tested by the Survey. These include materials for more than 300 public buildings in various States and Territories, recently authorized by Congress and involving an expenditure of more than $50,000,000. The cement, sand, stone, and other structural materials for use in the engineering work of the Panama Canal, as well as structural materials for use by the Reclamation Service and by several bureaus of the army and the navy, are also being examined at the testing laboratories of the Survey at St. Louis and Pittsburg.

DISTRIBUTION OF PUBLICATIONS.

The realization that the Survey publications which embody the results of the investigations and surveys can serve their purpose only as wise and prompt distribution is effected has caused special attention to be given to this phase of administration. The results attained are gratifying. In the distribution of reports the increase was nearly 10 per cent over that of the preceding year and the number of volumes distributed equaled the number of copies received from the Public Printer. The whole number of topographic maps distributed exceeded that of 1907–8 by over 25 per cent, and the sales of geologic folios and of topographic sheets showed an increase of 25 per cent and 20 per cent, respectively.

SURVEY LIBRARY.

In the Survey library the constant aim has been to make the collection complete in the literature properly belonging to a geologic library; to keep it up to date by promptly procuring all the necessary new publications; and to catalogue punctually the new accessions, thus making them readily available for use. With small funds, a working force necessarily limited, and shelf room so meager that continual shifting of books is necessary to incorporate new accessions in proper order, no remarkable increase in size or achievement is possible. The best efforts of the force are so fully engaged in meeting from day to day the demands for information and publications that only occasional opportunity is left for new undertakings that may increase the library's usefulness. The Survey has a collection of geologic, paleontologic, and mining literature which certainly is not approached in completeness by any other library in this country, and, at least as to American geology, probably not by any other in the world. It is gratifying to know that practical geologists, professors, and students throughout the country recognize the usefulness and completeness of this collection and frequently avail themselves of its resources, particularly of the rare material not to be found elsewhere in the United States.

INADEQUACY OF RENTED BUILDINGS.

The work of the scientific, technical, and clerical employees of the Survey is becoming more and more hampered through the conditions imposed by the quarters occupied. The two fires within the past fiscal year were fortunately extinguished with an aggregate material loss of less than $20,000, but the work of several divisions was much delayed by reason of these fires. Not only is there this constant danger that public records conservatively valued at nearly $5,000,000 may be destroyed by fire, but the space available is both ill adapted and insufficient for the present needs. The proportion of dark rooms necessitates use of artificial light, which in turn affects the quality and quantity of work and injures the eyesight and health of the employees. Furthermore, the present crowded condition of the rooms is curtailing the efficiency of the geologists and other specialists of the Survey, who are engaged in work of the greatest importance to the nation. The erection of a well-lighted, fireproof building of adequate size, planned to meet the requirements of a scientific bureau, has become the greatest need of the Geological Survey.

WORK OF THE YEAR.

PUBLICATIONS.

The Survey is a bureau of investigation and publication, and the current publications furnish an important index to the nature and value of its work. Summaries of the publications other than topographic maps issued during the last fiscal year follow:

Twenty-ninth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1908. v, 99 pp., 2 pls.

A summary of the work of the year, by branches and divisions, with notes on special features, brief sketches of the publications, and maps showing areas covered by geologic and topographic surveys.

Professional Paper 58. The Guadalupian fauna, by George H. Girty. 651 pp., 31 pls.

An account, with description and figures, of the fauna found in the Texas portion of the Guadalupe Mountains, a facies strikingly individual among known Carboniferous faunas. The introduction contains a summary of literature dealing with other Carboniferous faunas in various parts of the world.

Professional Paper 59. Contributions to the Tertiary paleontology of the Pacific coast. I. The Miocene of Astoria and Coos Bay, Oregon, by William H. Dall. 278 pp., 33 pls., 14 text figures.

The first of a projected series of contributions to a better knowledge of the Tertiary faunas of the Pacific States. Contains descriptions and figures of fossils, including an account by F. W. True of a remarkable fossil sea lion. As appendices are reprinted several rare papers on the paleontology of the Pacific coast Tertiary, followed by a bibliography of publications on the post-Eocene marine mollusks of the northwest coast, 1865–1908.

Professional Paper 60. The interpretation of topographic maps, by Rollin D. Salisbury and Wallace W. Atwood. 84 pp., 170 pls., 34 text figures.

A clear explanation of the features shown on the topographic and geologic maps published by the Survey and of the conventions used to represent those features, accompanied by a large number of illustrative maps with text indicating the inferences as to the topography, geology, and physiographic history that may be legitimately drawn from the maps.

Professional Paper 61. Glaciation of the Uinta and Wasatch mountains, by Wallace W. Atwood. 96 pp., 15 pls., 24 text figures.

An outline of the topography and geology of the two ranges, with detailed notes on the glacial phenomena, illustrated by geologic and topographic maps, half-tone views, and numerous sketch maps and diagrams.

Professional Paper 62. The geology and ore deposits of the Cœur d'Alene district, Idaho, by Frederick L. Ransome and Frank C. Calkins. 203 pp., 29 pls., 23 text figures.

The introduction, by Mr. Ransome, contains an outline of the geography and geology of northern Idaho and adjacent parts of Montana and Washington, a sketch of industries and settlements in the Cœur d'Alene district, and a bibliography, and is followed by detailed accounts of the general geology by Mr. Calkins and of the ore deposits and mines by Mr. Ransome. The report is illustrated by detailed and sketch maps, diagrams, sections, half-tone views, and photomicrographs of ores and rocks.

Professional Paper 63. Economic geology of the Georgetown quadrangle, Colorado, by Josiah E. Spurr and George H. Garrey, with general geology by Sydney H. Ball. 422 pp., 87 pls., 155 text figures.

An elaborately illustrated report on a well-known mining region, containing an account of the general geology, a discussion of the principles governing mineralization in this and related regions, notes on the history and statistics of production of the mines, and detailed descriptions of the mines by districts. The illustrations comprise maps showing the present topography, the geology, and the physiographic history of the region, mine plans and sections, sketches and views of rocks and ores, and numerous half-tone views.

Bulletin 340. Contributions to economic geology, 1907. Part I. Metals and nonmetals except fuels: C. W. Hayes and Waldemar Lindgren, geologists in charge. 482 pp., 6 pls., 26 text figures.

Introductory papers by Messrs. Hayes and Lindgren summarize the publications and field work of the year bearing on nonmetallic mineral resources except coal, lignite, and peat, and on deposits of metalliferous ores. The body of the volume comprises the following papers:

A geological analysis of the silver production of the United States in 1906, by Waldemar Lindgren.

Notes on some gold deposits of Alabama, by H. D. McCaskey.

The mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz., by F. C. Schrader.

Gold placer deposits near Lay, Routt County, Colo., by H. S. Gale.

Gold deposits of the Little Rocky Mountains, Montana, by W. H. Emmons.

Geology and mineral resources of the Osceola mining district, White Pine County, Nev., by F. B. Weeks.

The mines of the Riddles quadrangle, Oregon, by J. S. Diller and G. F. Kay.

Notes on copper deposits in Chaffee, Fremont, and Jefferson counties, Colo., by Waldemar Lindgren.

Notes on the Fort Hall mining district, Idaho, by F. B. Weeks and V. C. Heikes.

Mineral resources of northeastern Oklahoma, by C. E. Siebenthal.

Some molybdenum deposits of Maine, Utah, and California, by F. L. Hess.

The Arkansas antimony deposits, by F. L. Hess.

Antimony in southern Utah, by G. B. Richardson.

Carnotite and associated minerals in western Routt County, Colo., by H. S. Gale.

Tungsten deposits in the Snake Range, White Pine County, eastern Nevada, by F. B. Weeks.

Note on a tungsten-bearing vein near Raymond, Cal., by F. L. Hess.

Monazite deposits of the Carolinas, by D. B. Sterrett.

Minerals of the rare-earth metals at Baringer Hill, Llano County, Tex., by F. L. Hess.

Tin ore at Spokane, Wash., by A. J. Collier.

An estimate of the tonnage of available Clinton ore in the Birmingham district, Alabama, by E. F. Burchard.

Three deposits of iron ore in Cuba, by A. C. Spencer.

Iron ores near Ellijay, Ga., by W. C. Phalen.

The Miner ranch oil field, Contra Costa County, Cal., by Ralph Arnold.

Petroleum in southern Utah, by G. B. Richardson.

Gas fields of the Bighorn Basin, Wyoming, by C. W. Washburne.

The Labarge oil field, central Uinta County, Wyo., by A. R. Schultz.

Marble of White Pine County, Nev., near Gandy, Utah, by N. H. Darton.

Concrete materials produced in the Chicago district, by E. F. Burchard.

Portland cement materials near El Paso, Tex., by G. B. Richardson.

Clays in the Kootenai formation near Belt, Mont., by C. A. Fisher.

Tripoli deposits near Seneca, Mo., by C. E. Siebenthal and R. D. Mesler.

Phosphate deposits in the western United States, by F. B. Weeks.

Sulphur deposits at Cody, Wyo., by E. G. Woodruff.

A commercial occurrence of barite near Cartersville, Ga., by C. W. Hayes and W. C. Phalen.

Graphite deposits near Cartersville, Ga., by C. W. Hayes and W. C. Phalen.

Meerschaum in New Mexico, by D. B. Sterrett.

Bulletin 341. Contributions to economic geology, 1907. Part II. Coal and lignite; Marius R. Campbell, geologist in charge. 444 pp., 25 pls., 7 text figures.

Contains an introduction by Mr. Campbell, giving an outline of the geologic work in the coal fields of the country during 1907, followed by the papers named below:

The Sentinel Butte lignite field, North Dakota and Montana, by A. G. Leonard and C. D. Smith.

The Miles City coal field, Montana, by A. J. Collier and C. D. Smith.

The Bull Mountain coal field, Montana, by L. H. Woolsey.

Coal near the Crazy Mountains, Montana, by R. W. Stone.

The Red Lodge coal field, Montana, by E. G. Woodruff.

The Lewistown coal field, Montana, by W. R. Calvert.

The Sheridan coal field, Wyoming, by J. A. Taff.

The Glenrock coal field, Wyoming, by E. W. Shaw.

Coal fields of the northeast side of the Bighorn Basin, Wyoming, and of Bridger, Mont., by C. W. Washburne.

Coal fields of the southwest side of the Bighorn Basin, Wyoming, by E. G. Woodruff.

The eastern part of the Great Divide Basin coal field, Wyoming, by E. E. Smith.

The western part of the Little Snake River coal field, Wyoming, by M. W. Ball.

The northern part of the Rock Springs coal field, Sweetwater County, Wyo., by A. R. Schultz.

Coal fields of northwestern Colorado and northeastern Utah, by H. S. Gale.

The Grand Mesa coal field, Colorado, by W. T. Lee.

The coal field between Gallina and Raton Spring, N. Mex., in the San Juan coal region, by J. H. Gardner.

The coal field between Durango, Colo., and Monero, N. Mex., by J. H. Gardner.

The coal field between Gallup and San Mateo, N. Mex., by J. H. Gardner.

The Harmony, Colob, and Kanab coal fields, southern Utah, by G. B. Richardson.

The Rogue River valley coal field, Oregon, by J. S. Diller.

A coal prospect on Willow Creek, Morrow County, Oreg., by W. C. Mendenhall.

The Pocket coal district, Virginia, in the Little Black Mountain coal field, by C. A. Fisher.

Classified list of papers dealing with coal, coke, lignite, and peat, contained in publications of the United States Geological Survey, except those on Alaska, by W. T. Lee and J. M. Nickles.

Bulletin 345. Mineral resources of Alaska, report on progress of investigations in 1907, by Alfred H. Brooks and others. 294 pp., 5 pls., 7 text figures.

Contains fourteen different papers by eleven different authors, including (1) summaries of progress of the mining industry in various parts of the Territory during the year, (2) preliminary accounts of investigations in progress or completed, and (3) statements of the results of minor investigations not to be published elsewhere. A list of the papers with their authors follows:

The distribution of mineral resources in Alaska, by A. H. Brooks.

The mining industry in 1907, by A. H. Brooks.

Prospecting and mining gold placers in Alaska, by J. P. Hutchins.

Lode mining in southeastern Alaska, 1907, by C. W. Wright.

Copper deposits in Kasaan Peninsula, Prince of Wales Island, by C. W. Wright and Sidney Paige.

The building stones and materials of southeastern Alaska, by C. W. Wright.

Mineral resources of the Kotsina and Chitina valleys, Copper River region, by F. H. Moffit and A. G. Maddren.

Notes on copper prospects of Prince William Sound, by F. H. Moffit.

Occurrence of gold in the Yukon-Tanana region, by L. M. Prindle.

The Fortymile gold-placer district, by L. M. Prindle.

Water supply of the Fairbanks district, 1907, by C. C. Covert.

Investigations of the mineral deposits of Seward Peninusla, by P. S. Smith.

The Seward Peninsula tin deposits, by Adolph Knopf.

The mineral deposits of the Lost River and Brooks Mountain region, Seward Peninsula, by Adolph Knopf.

Water supply of the Nome and Kougarok regions, Seward Peninsula, 1906–7, by F. F. Henshaw.

Bulletin 346. Structure of the Berea oil sand in the Flushing quadrangle, Harrison, Belmont, and Guernsey counties, Ohio, by W. T. Griswold. 30 pp., 2 pls.

A report of the results of work undertaken to determine the position in all parts of the Flushing quadrangle of the principal oil sand and thus to ascertain where the conditions are favorable for the accumulation of oil and gas. Contains two maps showing by contours the depth of the oil sand and the structure of the Pittsburg coal, an important key bed.

Bulletin 347. The Ketchikan and Wrangell mining districts, Alaska, by F. E. Wright and C. W. Wright. 210 pp., 12 pls., 23 text figures.

A reconnaissance report on the distribution, character, and relative importance of the ore bodies and ore-bearing formations in this region, with detailed descriptions of the various mines and prospects. The illustrations include three large maps and many smaller ones.

Bulletin 348. Coal resources of the Russell Fork basin in Kentucky and Virginia, by Ralph W. Stone. 127 pp., 8 pls., 25 text figures.

A detailed description of the Elkhorn coal district in Virginia, with sketches of the geography and general geology, illustrated by maps and numerous sections of coal beds.

Bulletin 349. Economic geology of the Kenova quadrangle, Kentucky, Ohio, and West Virginia, by W. C. Phalen. 158 pp., 6 pls., 21 text figures.

Descriptions of the topography, geology, and mineral resources by districts, with an account of the transportation facilities and the extent and development of the mines. Contains structure sections of coals and other illustrations.

Bulletin 350. Geology of the Rangely oil district, Rio Blanco County, Colo., with a section on the water supply. 61 pp., 4 pls., 1 text figure.

A review of the geology in detail, with descriptions of the oil fields and water supply and a discussion of the economic development of the district. The illustrations consist of topographic and geologic maps.

Bulletin 351. The clays of Arkansas, by John C. Branner. 247 pp., 1 pl., 20 text figures.

A description of the topography and geology of the State, and of the character, origin, occurrence, and uses of Arkansas clays, with a table showing the value of the clay products and a list of the clay workers. Contains structure sections of various districts.

Bulletin 352. Geologic reconnaissance of a part of western Arizona, by W. T. Lee, with notes on the igneous rocks of western Arizona, by Albert Johannsen. 96 pp., 11 pls., 16 text figures.

Geographic and geologic details of the highlands and valleys of the area, with an account of its geologic history and a sketch of its water supplies. The illustrations consist of maps, cross sections, and half-tone views.

Bulletin 353. Geology of the Taylorsville region, California, by J. S. Diller. 218 pp., 5 pls., 12 text figures.

Detailed descriptions of the topography and geology of the region, with a sketch of its geologic history and an account of the development of its mineral resources. Contains topographic and geologic maps and other illustrations.

Bulletin 354. The chief commercial granites of Massachusetts, New Hampshire, and Rhode Island, by T. Nelson Dale. 228 pp., 9 pls., 27 text figures.

Detailed scientific and economic discussions of granite, including its origin, texture, and physical properties, and descriptions of the granites and quarries of the three States mentioned, with a glossary of scientific and quarry terms and numerous illustrations. The second publication in a series on the granites of New England.

Bulletin 355. The magnesite deposits of California, by Frank L. Hess. 67 pp., 12 pls., 4 text figures.

A sketch of the occurrence of magnesite in this State, with a description of the deposits and statistics concerning the deposits in foreign countries. Half-tone illustrations show features of structure at different mines.

Bulletin 356. Geology of the Great Falls coal field, Montana, by C. A. Fisher. 85 pp., 12 pls., 2 text figures.

Designed mainly to furnish information regarding the character and extent of the coal resources of the region. Includes a description of the rock formations, indicating their character, distribution, structure, and stratigraphic relations, and a brief statement of mineral resources other than coal. The illustrations show sections of coal in various districts.

Bulletin 357. Preliminary report on the geology and oil resources of the Coalinga district, Fresno and Kings counties, Cal., by Ralph Arnold and Robert Anderson. 142 pp., 2 pls., 1 text figure.

A brief abstract of the report to be issued later as Bulletin 398, prepared to meet the urgent demand for early publication of available facts.

Bulletin 358. Geology of the Seward Peninsula tin deposits, Alaska, by Adolph Knopf. 71 pp., 9 pls., 7 text figures.

A presentation of the chief facts regarding the mineralogy and geology of the tin deposits of the peninsula, with an account of the developments and geologic and topographic maps.

Bulletin 359. Magnetite deposits of the Cornwall type in Pennsylvania, by Arthur C. Spencer. 102 pp., 20 pls., 21 text figures.

A sketch of the geology of eastern Pennsylvania, with a general description of the ore deposits in Berks and York counties and in the vicinity of Cornwall. Contains structure and cross sections of some of the mines and geologic maps.

Bulletin 361. Cenozoic mammal horizons of western North America, by H. F. Osborn, with faunal lists of Tertiary Mammalia of the West by W. D. Matthew. 138 pp., 3 pls., 15 text figures.

An outline of the geologic and climatic history of the Tertiary period in the West, a discussion of correlation, and a description, in order of age, of the horizons at which fossil mammals have been found and of the characteristics of the faunas occurring at these horizons.

Bulletin 362. Mine sampling and chemical analyses of coals tested at the United States fuel-testing plant, Norfolk, Va., in 1907, by John S. Burrows. 23 pp.

A report on the analyses of coals made on the grounds of the Jamestown Exposition.

Bulletin 363. Comparative tests of run-of-mine and briquetted coal on locomotives, including torpedo-boat tests and some foreign specifications for briquetted fuel, by W. F. M. Goss. 57 pp., 4 pls., 35 text figures.

A report on tests of coal and briquets at a railroad testing plant, in locomotives on the road, and on a torpedo boat, with notes on the briquet industry.

Bulletin 364. Geology and mineral resources of Laramie Basin, Wyoming: a preliminary report by N. H. Darton and C. E. Siebenthal. 81 pp., 8 pls., 1 text figure.

A sketch of the geography and geology of the basin and a description of its mineral resources. Contains a geologic map, structure sections, and views showing characteristic features of the topography and rock outcrops.

Bulletin 365. The fractionation of crude petroleum by capillary diffusion, by J. E. Gilpin and M. P. Cram, under the supervision of D. T. Day. 33 pp., 3 text figures.

A report on experiments in which crude petroleum was allowed to diffuse upward through tubes packed tightly with fuller's earth.

Bulletin 366. Tests of coal and briquets as fuel for house-heating boilers, by D. T. Randall. 44 pp., 3 pls., 2 text figures.

An account of tests of raw and washed coal and of briquets in three boilers of a size commonly used in residences, with deductions from the results obtained.

Bulletin 367. The significance of drafts in steam-boiler practice, by W. T. Ray and Henry Kreisinger. 61 pp., 26 text figures.

A theoretical discussion, based on experiments at the Survey testing plants and tests on a railway locomotive, with numerous diagrams.

Bulletin 368. Washing and coking tests of coal at the fuel-testing plant, Denver, Colo., July 1, 1907, to June 30, 1908, by A. W. Belden, G. R. Delamater, and J. W. Groves. 54 pp., 2 pls., 3 text figures.

Details of the tests, with chemical analyses of the coals used, both before and after testing.

Bulletin 369. The prevention of mine explosions, report and recommendations, by Victor Watteyne, inspector-general of mines, Belgium; Carl Meissner, councillor for mines, Germany; and Arthur Desborough, H. M. inspector of explosives, England, with letter of transmittal by James Rudolph Garfield, Secretary of the Interior. 11 pp.

A report made at the request of the Secretary of the Interior by three mining experts from Belgium, Germany, and England.

Bulletin 370. The fire-resistive properties of various building materials, by Richard L. Humphrey. 99 pp., 39 pls., 32 text figures.

Results of tests of 30 panels to determine the effect of fire and subsequent quenching with water. Contains numerous reproductions of photographs showing the condition of the panels before and after testing, diagrams showing temperature conditions, and tables giving results of compression tests on fragments remaining after fire tests.

Bulletin 371. Reconnaissance of the Book Cliffs coal field between Grand River, Colorado, and Sunnyside, Utah, by G. B. Richardson. 54 pp., 10 pls., 1 text figure.

An account of the topography, climate, and geology of the area and a description of its coal resources, including statements as to occurrence, amount, and character of the coal and notes on the mining development. Contains a geologic map, numerous sections, and views of typical geologic and other features.

Bulletin 372. Bibliography of North American geology for 1906 and 1907, with subject index, by F. B. Weeks and J. M. Nickles. 317 pp.

A bibliography, arranged by authors, of publications relating to North American geology, with descriptive notes, and an index by subjects, with special lists of chemical analyses, geologic formations, rocks, and minerals.

detailed discussion of the conditions in the various counties, with maps showing distribution of rocks and water and a table of deep wells.

Water-Supply Paper 224. Some desert watering places in southeastern California and southwestern Nevada, by Walter C. Mendenhall. 98 pp., 4 pls.

Notes on the topography of the region, especially as concerns the location of known watering places and the possibilities for finding and developing water at other favorable points, with descriptions of the main routes of travel and hints on desert traveling, accompanied by a map showing the location of the watering places described.

Water-Supply Paper 225. Ground waters of the Indio region, California, with a sketch of the Colorado Desert, by Walter C. Mendenhall. 56 pp., 12 pls., 5 text figures.

A geologic sketch of the district, an account of its water resources, and a brief history of its development, with a list of the producing wells. The illustrations include half-tone views of the region and a map showing wells, artesian areas, and irrigated lands.

Water-Supply Paper 226. The pollution of streams by sulphite pulp waste—a study of possible remedies, by Earle B. Phelps. 37 pp., 1 pl.

A discussion of the injurious effects of sulphite pulp waste on streams and of possible methods of purifying it and of making use of its valuable contents, with a description of the manufacture of wood pulp and a diagram illustrating the various steps in the process.

Water-Supply Paper 228. Water-supply investigations in the Yukon-Tanana region, Alaska, 1907 and 1908, Fairbanks, Circle, and Rampart districts, by C. C. Covert and C. E. Ellsworth. 108 pp., 7 pls.

An account of the stream-measurement work and the establishment of gaging stations, with an explanation of the methods of carrying on the work and collecting the data and tables showing the daily gage height and estimated discharge of the various streams. Contains maps and other illustrations showing the hydraulic development of the region.

Water-Supply Paper 229. The disinfection of sewage and sewage-filter effluents, with a chapter on the putrescibility and stability of sewage effluents, by E. B. Phelps. 91 pp., 1 pl.

A discussion of the necessity for sewage purification, with an account of the methods and costs of disinfection, experimental investigations, and practical applications. Contains disinfection and relative stability tables.

Water-Supply Paper 230. Surface-water supply of Nebraska, by J. C. Stevens. 251 pp., 6 pls., 5 text figures.

A report of stream measurements in Nebraska to the end of 1908, with descriptions of the several drainage basins and tables showing the daily gage height and discharge of the streams. Contains illustrations typical of the rivers of the State.

Water-Supply Paper 231. Geology and water resources of the Harney Basin region, Oregon, by G. A. Waring. 93 pp., 5 pls.

A sketch of the topography, geology, and physiography of the district and of the sources and distribution of both surface and underground water, with suggestions as to conservation of the water supply and details of the several basins. Contains geologic and topographic maps of the region and other illustrations.

Mineral resources of the United States, calendar year 1907. Part I, Metallic products, 743 pp., 1 pl., 1 text figure. Part II, Nonmetallic products, 897 pp., 1 pl., 6 text figures.

Statistics of production of mineral substances in the United States, including an account of the chief features of mining progress, and comparisons of past and present conditions. This report is a consolidation of 50 separate chapters, each treating of a separate mining industry, published in pamphlet form in advance of the publication of the volume.

Advance chapters from "Mineral resources of the United States, calendar year 1908" as follows: The production of monazite and zircon in 1908, by Douglas B. Sterrett, 6 pp. The production of salt and bromine in 1908, by W. C. Phalen, 18 pp. The production of bauxite and aluminum in 1908, by W. C. Phalen, 14 pp. The production of phosphate rock in 1908, by F. B. Van Horn, 16 pp. The production of slate in 1908, by A. T. Coons, with general note on the classification and characteristics of slate, by T. Nelson Dale, 15 pp. The production of mica in 1908, by Douglas B. Sterrett, 14 pp.

Statistics of production of the minerals, chief features of mining progress, and comparisons of past and present conditions as in previously published reports.

Geologic folio 160. Description of the Accident and Grantsville quadrangles, comprising 460 square miles, of which the greater part is in the northwest corner of Maryland, but including also portions of Fayette and Somerset counties, Pa., and Preston County, W. Va. Prepared under the supervision of William Bullock Clark, state geologist of Maryland, by G. C. Martin. 14 folio pages of text, 6 maps, 2 structure sections, and 2 columnar sections.

Geologic folio 161. Description of the Franklin Furnace quadrangle, comprising an area of about 225 square miles in northwestern New Jersey, by A. C. Spencer, H. B. Kümmel, J. E. Wolff, R. D. Salisbury, and Charles Palache. Surveyed in cooperation with the State of New Jersey. 27 folio pages of text, 5 maps, and 1 structure-section sheet.

Geologic folio 162. Description of the Philadelphia district, an area 915 square miles in extent, consisting of four quadrangles—the Germantown, Norristown, Philadelphia, and Chester. The district lies in three States—Pennsylvania, New Jersey, and Delaware. Surveyed in cooperation with the State of New Jersey. The description is by F. Bascom, W. B. Clark, N. H. Darton, H. B. Kümmel, R. D. Salisbury, B. L. Miller, and G. N. Knapp. 23 folio pages of text, 8 maps, 2 structure sections, 2 columnar sections, and 1 sheet of illustrations exhibiting geologic features.

Geologic folio 163. Description of the Santa Cruz quadrangle, embracing a land area of 712 square miles in west-central California and a water area of 332 square miles in the adjoining part of the Pacific Ocean, by J. C. Branner, J. F. Newsom, and Ralph Arnold. 11 folio pages of text, 3 maps, 1 structure-section sheet, 1 columnar-section sheet, 1 page of illustrations exhibiting geologic features, and 1 page showing fossils found in the quadrangle.

Geologic folio 164. Description of the Belle Fourche quadrangle, an area 849 square miles in extent in northwestern South Dakota, by N. H. Darton and C. C. O'Harra. 9 folio pages of text, 4 maps, 1 structure section, and 1 columnar section.

Geologic folio 165. Description of the Aberdeen-Redfield district, which includes the Northville, Aberdeen, Redfield, and Byron quadrangles, covering 1,692 square miles near the central part of South Dakota, by J. E. Todd. 13 folio pages of text and 12 maps.

Geologic folio 166. Description of the El Paso quadrangle, comprising 894 square miles in the northwestern corner of that part of Texas which lies west of Pecos River, by G. B. Richardson. 11 folio pages of text, 2 maps, and 1 sheet of illustrations showing geologic features.

NOTE.—Folios 164, 165, and 166 are published also in octavo form for field use.

FIELD WORK BY THE DIRECTOR.

During the field season of 1908 the Director visited geologic parties in Wyoming, Montana, and New Mexico and topographic parties in Mississippi. He also had field conferences with the administrative officers of the Survey, geologists, engineers, and cooperating state officials. He attended the irrigation congress at Albuquerque, the mining congress at Pittsburg, and meetings of the West Virginia Coal Miners' Association at Charleston, W. Va., of the Illinois Coal Conference at Urbana, and of the Geological Society of America at Baltimore.

GEOLOGIC BRANCH.

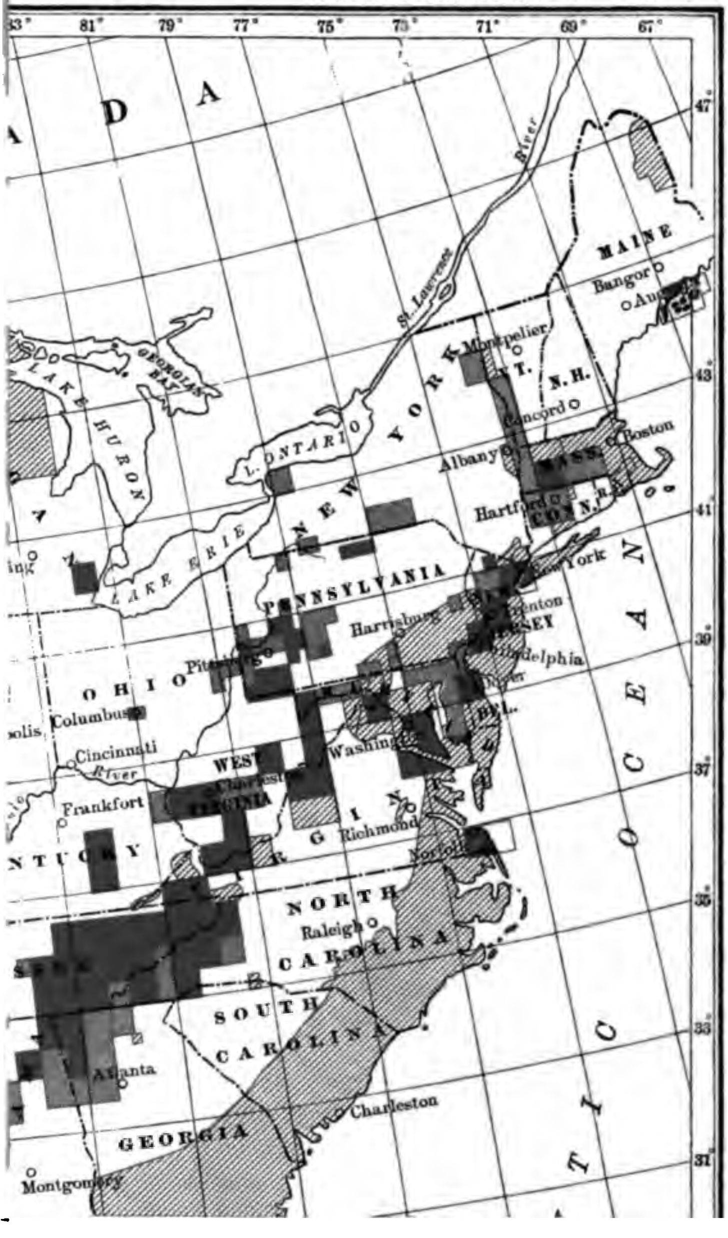
ADMINISTRATION.

The geologic branch consists of four divisions, each in charge of an administrative chief, viz, (1) geology and paleontology, C. W. Hayes in charge; (2) Alaskan mineral resources, A. H. Brooks in charge: (3) mineral resources, E. W. Parker in charge; and (4) chemical and physical research, G. F. Becker in charge.

General supervision of the work of the geologic branch is exercised by the chief geologist, C. W. Hayes, with a view to securing proper cooperation between the several divisions and coordination of the several lines of work. It is often to the advantage of the Survey to employ the members of one division in the work of another and the form of organization facilitates such transfers when exigencies demand it. The cooperation between the divisions of geology and mineral resources is especially close, and a large proportion of the annual volume issued by the latter division is prepared by members of the division of geology who are detailed for this work during a part of each year.

PUBLICATIONS.

The publications of the year prepared in the geologic branch included 7 geologic folios, 5 professional papers, 25 bulletins, and the annual volume on mineral resources. Besides these a large number of papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies, and some original matter obtained incidentally during the course of the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Concord
NEW YORK
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MASS.
Boston
Hartford
CONN.
R.I.
New York
PENNSYLVANIA
Harrisburg
Trenton
JERSEY
Philadelphia
Pittsburg
OHIO
Columbus
Cincinnati
River
DEL.
Washington
WEST VIRGINIA
Charleston
Frankfort
KENTUCKY
VIRGINIA
Richmond
Norfolk
NORTH CAROLINA
Raleigh
SOUTH CAROLINA
Charleston
Atlanta
GEORGIA
Montgomery
ATLANTIC OCEAN

work and not appropriate for official reports has also been made the subject of unofficial publications. Such publications are ordinarily restatements of results in a more technical form and are usually prepared by members of the Survey without compensation.

The progress of geologic mapping during the year, as represented in the publications of the Survey, is shown on Plate I.

DIVISION OF GEOLOGY AND PALEONTOLOGY.

PERSONNEL AND ORGANIZATION.

The scientific force at the beginning of the year consisted of 51 geologists and paleontologists, 48 assistant geologists, and 31 junior geologists. During the year there were 13 resignations and 13 appointments. Of the total number on the rolls, 86 were continuously employed, 27 gave only a portion of their time to Survey work, and 17 were not employed during the year. In addition to the above regular force, 45 temporary field assistants were employed for a portion of the year.

For purposes of scientific supervision, to which in some cases is added direct administrative control, the work of the division is organized under a number of sections, viz:

Areal and structural geology, Arthur Keith in charge.
Paleontology and stratigraphic geology, T. W. Stanton in charge.
Economic geology, metalliferous ores, Waldemar Lindgren in charge.
Economic geology, fuels, M. R. Campbell in charge.
Land classification, A. C. Veatch in charge.

The functions of the section chiefs include the preparation of plans and supervision of field and office work as well as review and revision of results. They are directly responsible for keeping the Survey work up to a high scientific standard.

FIELD WORK BY THE CHIEF GEOLOGIST.

During July, 1908, the chief geologist visited field parties in Arkansas, Oklahoma, and New Mexico. He also made an examination of the geologic conditions at the site of the proposed Elephant Butte dam, at the request of the Reclamation Service. In October he visited a party in Tennessee and made a brief examination of geologic conditions in the Louisiana oil fields where work was in progress in cooperation with the State Survey. In November he visited a number of State geologists and mining engineers in different parts of the country in connection with the preparation of estimates of iron-ore reserves of the United States. In March and April he visited the principal oil fields of Mexico for the purpose of obtaining information of value in planning and directing work in the oil fields of the United States. In June he visited the oil fields of Oklahoma in connection with work there in progress.

GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

New England.—In Maine cooperative geologic work was continued under the supervision of E. S. Bastin. The mapping of the Eastport quadrangle was conducted by Mr. Bastin, assisted by C. L. Breger, the paleontologic studies being made by H. S. Williams. The preparation of this folio was well advanced.

Some additional work was done in the Frenchmans Bay quadrangle by C. W. Brown.

A report on the peat deposits of Maine (Bulletin 376) was completed by E. S. Bastin in cooperation with C. A. Davis, of the technologic branch, and considerable progress was made on a report on the pegmatites of Maine by Mr. Bastin.

The report on the fauna of the Chapman sandstone of Maine was nearly completed by H. S. Williams.

The inspection of the granite quarries of Connecticut was completed by T. N. Dale, and his report thereon is nearly finished. Mr. Dale also made considerable progress on the Mettawee, Fort Ticonderoga, and Fort Ann folios. In the spring he was transferred temporarily to the technologic branch, for the purpose of inspecting materials for eight government buildings in Massachusetts, Connecticut, and Rhode Island.

The text to accompany the general map of Massachusetts and Rhode Island, which has been prepared on a scale of 4 miles to the inch, was completed by B. K. Emerson. A preliminary map of the Keene (N. H.) and Warwick (Mass.) quadrangles was also prepared by Professor Emerson, and the maps and text covering the eastern half of the Housatonic quadrangle were completed and submitted for publication.

The survey of the surficial geology of the Taconic quadrangle, in Massachusetts, was substantially completed by F. B. Taylor.

In Vermont a field study of the stratigraphy and structure of the north end of the Taconic Mountains and adjacent areas was made by Arthur Keith, E. O. Ulrich, and T. N. Dale. Reconnaissances were also made by Mr. Keith in the Burlington, Middleburg, and Rutland quadrangles, particularly with reference to the structure of the Green Mountains. In these reconnaissances special consideration was given to the Ordovician and Cambrian limestones.

Considerable time has been devoted by Arthur Keith and others to general studies of the geology of Massachusetts and Vermont, with special reference to correlating the work of the different geologists in the New England field. This work will be supplemented during the coming year.

Atlantic and Gulf coastal plains.—In cooperation with the various state geological surveys, the studies of the Atlantic and Gulf coastal plains were continued throughout the year. W. B. Clark was in charge of the investigations in the northern part of the area and T. W. Vaughan in charge of those in the southern part of the area. In addition to office supervision, Messrs. Clark and Vaughan from time to time made visits to various districts for the purpose of studying some special features, with the view of correlating so far as possible the work in the different States. Under their direction a general survey of the geology and underground waters of the coastal plain of Virginia has been made by B. L. Miller, E. W. Berry, and Samuel Sanford. A similar survey of the coastal plain of North Carolina has been made by B. L. Miller and L. W. Stephenson. Special reports on these surveys are practically completed. They will be published as bulletins of the North Carolina and Virginia state geological surveys.

The greater part of the field work for the report on the coastal plain of Georgia has been completed, by L. W. Stephenson on behalf of the Federal Survey and by Otto Veatch on behalf of the Georgia Geological Survey. The report on the stratigraphy and underground waters of Florida, by G. C. Matson and Samuel Sanford, has been completed and submitted. It will be published as a bulletin of the Florida Geological Survey. The data accumulated in regard to the stratigraphy and underground waters of South Carolina will be utilized in a report, now in preparation, by the state geologist, Earl Sloan.

In addition to the general surveys above mentioned, the detailed survey of the Choptank quadrangle in Maryland was completed by B. L. Miller and H. P. Little, and the report is now in preparation. Considerable progress was also made in the detailed survey of the Tolchester quadrangle in Maryland and of the Elkton and Wilmington quadrangles in Delaware and Maryland.

A report on the geology of Long Island was completed and submitted by M. L. Fuller. A special study of the Lower Cretaceous formations of Delaware and Maryland was made by Arthur Bibbins, E. W. Berry, and H. P. Little.

In the study of the fossils, which play an important part in deciphering the stratigraphy of the Coastal Plain, valuable assistance has been rendered by Miss Julia A. Gardner, of Johns Hopkins University, and Dr. R. S. Lull, of Yale University.

Along the Gulf coast the work has included the preparation of a report in cooperation with the State on the geology of the Caddo oil fields of northwestern Louisiana, by G. D. Harris, state geologist, and a report on the geology and underground waters of the coastal plain of Texas east of Brazos River and south of Jefferson, by Alexander Deussen. This study is now being extended to the region of Brazos River.

Northern Appalachian region.—The Ordovician rocks on the west flank of the Adirondack uplift were studied by E. O. Ulrich, in association with H. P. Cushing and Rudolph Ruedeman, of the New York State Survey, and H. M. Ami, of the Canadian Survey. Instructive sections of the Ordovician in Rensselaer County, N. Y., were also studied by Mr. Ulrich and Doctor Ruedeman. One of the results was the acquirement of important data bearing on the stratigraphic relations of the horizons containing graptolite faunas.

Geologic mapping in Pennsylvania was conducted in cooperation with the State, which made an appropriation of $4,500 for the purpose. The work was in charge of G. H. Ashley, who was assisted by Charles Butts, M. J. Munn, E. W. Shaw, W. C. Phalen, and E. F. Lines.

A progress report reviewing the geology of all the quadrangles studied by this Survey in cooperation with the State was prepared by Mr. Ashley, assisted by Messrs. Butts, Munn, and R. W. Stone. This report has been published as a bulletin of the State Survey.

The areal and economic survey of the Hollidaysburg quadrangle, Pennsylvania, was finished by Charles Butts, and the resulting maps and folio text were carried nearly to completion. Mr. Butts also spent several weeks in the Barnesboro and Patton quadrangles studying recent mining developments and ascertaining their bearing on obscure geologic features in that region.

The survey of the Foxburg quadrangle was completed by E. W. Shaw, and the maps and text for the Foxburg-Clarion folio were prepared for publication. The survey of the Burgettstown quadrangle was also carried to completion by Mr. Shaw, and the text of a folio on the Burgettstown and Carnegie quadrangles was practically finished.

The preparation of the Johnstown folio, by W. C. Phalen, was completed. Mr. Phalen also prepared a special economic report on the mineral resources of this quadrangle.

The survey of the Sewickley quadrangle, by M. J. Munn, was finished, and the texts for a folio and an economic bulletin on that quadrangle were submitted. A bulletin on the economic resources of the Carnegie and Clarion quadrangles was also completed by Mr. Munn. The economic bulletins on the Sewickley and Clarion quadrangles will be published by the State.

The text for the Claysville folio is nearly finished, and work has been started in the Pittsburg, New Kensington, and Freeport quadrangles.

An investigation of the mineral-paint ores of eastern Pennsylvania was made by B. L. Miller and E. F. Burchard, assisted by four senior students of the Lehigh University. An abstract of the results of this work will be found in the report on the production of mineral paints in 1908. A more detailed report, which is now completed, will be included in the next annual economic bulletin.

The survey of the Gettysburg quadrangle was completed by G. W. Stose. The results of the survey of this quadrangle will be combined with those for the adjoining Fairfield quadrangle, to be surveyed during the present season, as a single folio.

The maps and text for the Pawpaw-Hancock (W. Va.-Md.-Pa.) folio were nearly completed by Mr. Stose, and that folio will soon be ready for publication.

Progress was made in the areal and economic survey of the Phoenixville and Honeybrook quadrangles, Pennsylvania, by Florence Bascom. This survey will be combined with that of the Reading and Boyertown quadrangles to furnish the material for one folio of the geologic atlas.

The survey of the crystalline formations of the Wilmington, West Chester, Coatesville, and Elkton quadrangles, covering parts of Pennsylvania, New Jersey, and Delaware, was completed by Miss Bascom.

Paleobotanic and stratigraphic studies were made by David White in the coal fields of the Beaver Falls quadrangle, Pennsylvania, and in the Short Mountain Pocono region of West Virginia. Preliminary reports embodying the results were submitted to the geologists in charge of the mapping.

The field survey of that portion of the Easton quadrangle, Pennsylvania, which lies west of Delaware River was completed by W. S. Bayley.

In cooperation with the New Jersey Geological Survey, Professor Bayley made a special study of the magnetite iron ores of New Jersey. His report will be published as a bulletin of the State Survey.

Considerable progress was made by Professor Bayley in the preparation of his report on the crystalline rocks and the economic resources of the Highlands area in the Raritan quadrangle, New Jersey.

A reconnaissance survey of the iron ores of the Appalachian region in Virginia was made by E. C. Harder, whose report will be found in Bulletin 380.

Southern Appalachian region.—The study of the iron ores of the Birmingham district, Alabama, was completed during the year, and the report, by Charles Butts, E. F. Burchard, and E. C. Eckel, is now in press as Bulletin 400. The maps and text for the Birmingham folio were also practically completed by Mr. Butts.

The areal and economic survey of the Brookwood quadrangle, Alabama, was carried nearly to completion by Mr. Butts, and considerable progress was made in the preparation of the maps and folio text. These can not, however, be completed until the new topographic base map is finished.

In the Dalton quadrangle, Georgia, half of the metamorphic area was mapped by W. C. Phalen.

Special studies were made of the metamorphosed sedimentary formations in the Suwanee and Cartersville quadrangles of Georgia by Arthur Keith, and in the Kings Mountain and Gaffney quadrangles of North Carolina and South Carolina by Mr. Keith and D. B. Sterrett. The latter area is considered the key to the geology of the Piedmont Plateau of North Carolina and South Carolina.

A reconnaissance of that part of the Dahlonega gold belt in Georgia which lies in Cherokee County, to the southwest of Dahlonega, was made by H. D. McCaskey. This district contains a larger number of mines and prospects than any other in the State. In cooperation with the State Geological Survey a preliminary geologic map of this district has been prepared for publication in the state report.

A study of the Clinton iron-ore deposits in the Chattanooga district of Tennessee and Georgia was made by E. F. Burchard, and a brief report published in Bulletin 380.

The maps and manuscript for the Woodbury (Tenn.) folio have been nearly completed by E. O. Ulrich, but it has been decided to withhold publication until the study of the adjoining Murfreesboro quadrangle is finished, the geology of the two quadrangles being closely related.

GEOLOGIC WORK IN THE CENTRAL STATES EAST OF 97°.

Geologic investigations in Illinois were continued in cooperation with the State Geological Survey, F. W. DeWolf being in charge of the work for the Federal Survey. Areal and economic maps of the West Frankford and Herrin quadrangles were completed, and additional studies of the surficial geology of the Galatia quadrangle were made. A report on the economic resources of the St. Louis quadrangle (Ill.-Mo.) was completed and submitted by N. M. Fenneman. A similar report on the Belleville and Breese quadrangles is in an advanced state of preparation.

In addition to the detailed surveys, reconnaissance surveys were made with reference to the correlation of the "Coal Measures" formations and the preparation of a structural contour map of the State. David White participated in the stratigraphic studies and devoted considerable time to paleobotanic and stratigraphic studies in the coal fields of Illinois and Indiana, and to the preparation of reports thereon. About 2,000 drill and shaft records were collected and studied by Mr. DeWolf.

In cooperation with the State of Indiana, G. H. Ashley, assisted by E. F. Lines and J. A. Udden, reviewed the geology of the coal fields of that State, collecting records of hundreds of recent drillings and visiting all areas of new development where the geology was in doubt. The report on this work has been published as a bulletin of the State.

Considerable progress was made in the study of the areal geology of the East Cincinnati and West Cincinnati quadrangles (Ohio-Ky.), which is being conducted under the supervision of E. O. Ulrich. The map of the Ordovician formations, chiefly by R. S. Bassler and J. M. Nickles, was completed. The delineation of the Pleistocene geology, which was assigned to N. M. Fenneman, is in progress.

The monograph on the Lake Superior region, a monumental work on which C. R. Van Hise and C. K. Leith, with the aid of various assistants, have been engaged for a long time, was brought to completion and transmitted for publication. This is an exhaustive study of one of the most complicated regions in the country, which is of special interest to both the scientific and the commercial world because of its intricate structure and its enormous deposits of iron and copper.

Detailed study and areal mapping of the glacial drift in Wisconsin were continued by W. C. Alden, chiefly in Sheboygan, Fond du Lac, Calumet, Manitowoc, Dodge, Washington, and Ozaukee counties and in parts of Columbia and Dane counties. This work was done under the supervision of T. C. Chamberlin. Considerable progress was made by Mr. Alden in the preparation of the report on the glacial geology of southeastern Wisconsin.

At the opening of the fiscal year Frank Leverett was in Europe—on a trip made at his own expense—for the purpose of making a comparison of the drift sheets there with those in North America. These studies were pursued in each of the large centers of glaciation, namely, Scandinavia, Great Britain, and the Alps, as well as in two small areas of glaciation, the Riesengebirge and the Black Forest of southern Germany. Much light was obtained on the variations in the amount of weathering and erosion displayed by the European drift sheets, which will be very helpful in interpreting the glacial history of America. A report on the principal results of these European studies has been prepared.

Considerable progress was made on the monograph on the Pleistocene of Indiana and Michigan, of which Mr. Leverett and F. B. Taylor are joint authors. This report now awaits the completion of the base maps, which are in course of preparation. During the year Mr. Taylor spent some time in a special study of the lake history and drift formations in the southwestern part of Ontario for the Canadian Geological Survey. This region has an important bearing on the glacial and lake history of America in general, and the studies have furnished data that will be of value in the completion of the monograph on the Pleistocene of Indiana and Michigan and in other investigations which are in progress. In connection with work on this monograph, additional field studies were made of certain beaches and moraines related to Lake Maumee, in northwestern Ohio.

An investigation of the existing condition of the lead and zinc industry of the Mississippi Valley was made by C. E. Siebenthal, who spent a month in the various lead and zinc camps in that region.

A field review of the complicated stratigraphic and faunal relations of the Paleozoic rocks in the Ouachita uplift of Arkansas and eastern Oklahoma was made by C. W. Hayes, E. O. Ulrich, J. A. Taff, and A. H. Purdue, for the purpose of obtaining data for an improved classification of the rocks of that region. During this conference parts of the Caddo Gap quadrangle in Arkansas and of the Tuskahoma, Atoka, and Ardmore quadrangles in Oklahoma were visited. On its conclusion Mr. Taff, assisted by W. J. Reed, reviewed the stratigraphy and structure of the McAlester, Tuskahoma, and Windingstair quadrangles, Oklahoma, with reference to the completion of the folios of those areas. A survey of the Mid-Continent oil field in Oklahoma was then begun, and the examination of the Morris-Bald Hill district was completed. As a result of these investigations, Mr. Taff, assisted by Mr. Reed, submitted brief reports on the grahamite of southeastern Oklahoma (in Bulletin 380) and on the Madill oil pool in Oklahoma (in Bulletin 381). He also has in preparation a more detailed report on the oil resources of Oklahoma and folios descriptive of the McAlester, Tuskahoma, and Windingstair quadrangles. In addition considerable time was devoted by Mr. Taff to the classification of the coal lands of Utah and Colorado.

The mapping of the Caddo Gap and Harrison quadrangles, Arkansas, was completed by A. H. Purdue, assisted by H. D. Miser and R. D. Mesler, and progress has been made in the preparation of the folios.

A report on the fauna of the Moorefield shale of Arkansas was completed by G. H. Girty.

Considerable progress was made by G. D. Harris in the preparation of a report on the Caddo oil field in Arkansas, Louisiana, and Texas. This work is being done in cooperation with the State Survey.

GEOLOGIC WORK IN THE WESTERN PUBLIC-LAND STATES AND TERRITORIES.

Rocky Mountain region.—One of the tasks assigned to the geologic branch at the beginning of the last fiscal year was the examination, for the purpose of classification and valuation, of about 16,000 square miles of supposed coal territory in the Rocky Mountain region. This work was placed in charge of M. R. Campbell, with C. A. Fisher as chief assistant. In order to cover this territory properly twelve field parties were organized and three independent workers were sent out. In addition there was undertaken, for the Bureau of Indian Affairs and in cooperation with the Reclamation Service, as provided in the act of May 30, 1908, an examination of the lignite beds of the Fort Peck Indian Reservation. For this investigation one large field party was organized and put in charge of C. D. Smith, making a total of thirteen field parties and three independent workers. During the winter the results of these field examinations were compiled in the office. This involved the preparation of geologic maps, of township plats showing the classification and valuation of the coal lands examined, and of preliminary reports on the geology of the regions. The following is a list of the areas examined and of the geologists in charge of the work:

Newcastle coal field, Wyoming. R. W. Stone.
Cambria coal field, Black Hills region, Wyoming. R. W. Stone.
Northwestern part of Great Divide coal basin, Wyoming. E. E. Smith.
Coal fields in southeastern part of Bighorn Basin, Wyoming. E. G. Woodruff.
Coal fields on north and east sides of Bighorn Mountains, Wyoming. H. S. Gale.
Coal fields in Wind River Basin, Wyoming. E. G. Woodruff.
Southeastern extension of the Hanna coal field, near Arlington, Wyo. M. W. Ball.
Southern part of Rock Springs coal field, Wyoming. A. R. Schultz.
Coal field in northern Wyoming which adjoins on the east the Sheridan coal field. R. W. Stone.
Eastern part of Little Snake River coal field, southern Wyoming. M. W. Ball.
Livingston coal field, Montana. W. R. Calvert.
Coal field in vicinity of Electric, Mont. W. R. Calvert.
Portion of Milk River coal field, northern Montana. L. J. Pepperberg.
North-central part of Bull Mountain coal field, Montana. R. W. Richards.
Fort Berthold Indian Reservation, N. Dak. (examination made for the Reclamation Service). C. D. Smith.
Vicinity of Washburn, N. Dak. (examination made for Reclamation Service). C. D. Smith.
Trinidad coal field, southern Colorado. G. B. Richardson.
Colorado Springs coal field, Colorado. M. I. Goldman and G. C. Martin.
Coal fields in vicinity of Canon City and South Park, Colo. C. W. Washburne.
Coal fields of north-central Colorado between Sedalia and the Wyoming state line. G. C. Martin.
Part of the Raton coal field east of the Maxwell land grant, in southern Colorado and northern New Mexico. W. T. Lee.
Several small coal fields in central New Mexico. J. H. Gardner.

In all the foregoing fields the special stratigraphic and paleontologic studies necessary for the correlation of the rocks of the different regions were made by T. W. Stanton and F. H. Knowlton.

At the request of the Bureau of Indian Affairs an examination of the Standing Rock and Cheyenne Indian reservations of North Dakota and South Dakota was undertaken April 1, 1909. This survey. which is provided for in the act of May 29, 1908 (35 Stat. L., 460–462), was placed in charge of W. R. Calvert. It will cover an area of 4,150 square miles, of which nearly one-half is supposed to be underlain by valuable lignite deposits. This investigation is still in progress. Three well-equipped field parties, under the personal direction of V. H. Barnett, A. L. Beekly, and M. A. Pishel, are engaged on the work.

In addition to the foregoing surveys, which were made for the purpose of classifying the lands with reference to their value as coal-producing territory, the following other surveys and investigations were carried on in the Rocky Mountain region during the last fiscal year:

The map and text for the Laramie-Sherman folio, Wyoming, were completed by N. H. Darton, C. E. Siebenthal, and Eliot Blackwelder, and submitted for publication.

A field study of the pre-Cambrian rocks of parts of British Columbia, Alberta, and Montana lying between the Crows Nest division of the Canadian Pacific Railway on the north and the main line of the Great Northern Railway on the south was made by C. D. Walcott, assisted by L. D. Burling. The object of this study, carried on chiefly at the expense of the Smithsonian Institution, was to ascertain the true relations of the rocks of that area to the pre-Cambrian rocks of central Montana and to the Cambrian rocks of the section along the main line of the Canadian Pacific Railway farther to the north.

The areal survey of the Philipsburg quadrangle, Montana, was completed by F. C. Calkins. Considerable progress was made in the preparation of the report, which will include a chapter on the ore deposits, by W. H. Emmons, who made a special study of that feature of the district. Mr. Emmons's report has been completed and submitted.

An areal survey of the Frisco (Utah) mining district was well advanced by B. S. Butler, under the supervision of Waldemar Lindgren, chief of the section of metalliferous deposits.

The report on the Park City mining district, Utah, is nearing completion. It has been delayed by the resignation, in September, 1908, of J. M. Boutwell, who had the matter in charge.

F. L. Hess spent a few weeks in a study of the tin, tantalum, and tungsten deposits of South Dakota. A brief report on these investigations will be found in Bulletin 380.

An examination of deposits of mica in South Dakota was made by D. B. Sterrett, and a brief report thereon prepared for Bulletin 380.

A study of the phosphate deposits of Idaho and Wyoming was begun in June by H. S. Gale, assisted by R. W. Richards and C. E.

Breger. The object of this work is the classification of land temporarily withdrawn from entry on account of its phosphate deposits. The report of G. H. Girty on the fauna of the Carboniferous phosphate beds of Utah, Idaho, and Wyoming, based on collections made in previous years, has been completed.

Progress was made in the preparation of a supplementary report on the complicated geology of the Leadville district, Colorado, by S. F. Emmons and J. D. Irving.

The study of the Breckenridge (Colo.) mining district was started during the fall by F. L. Ransome and will be continued during the present season.

An examination of the mining districts of eastern Gunnison County, Colo., was made by J. M. Hill. A brief report will be found in Bulletin 380.

Geologic mapping in the San Juan region of Colorado was continued by Whitman Cross, assisted by H. Bancroft and J. P. Iddings. During the season field work in the Lake City quadrangle was completed and the northern portion of the San Cristobal quadrangle was surveyed. The revision of the map and text for the Engineer Mountain folio, made necessary by the study of adjacent areas, was finished and the folio is now in process of publication. The reports on the Lake City and San Cristobal quadrangles await the completion of field work in adjoining districts. A bulletin on the ore deposits of the Lake City quadrangle is, however, well advanced.

A study of the Florence oil field, Colorado, was made by C. W. Washburne. A brief report on the investigation will be found in Bulletin 381.

A report on the metalliferous deposits of New Mexico was completed by Waldemar Lindgren.

An examination of the magnetite deposits of Hanover, N. Mex., was made by Sidney Paige, and a map of the area in which the principal mines are located was prepared. A report on this examination appears in Bulletin 380.

During the early part of the fiscal year a report on the mining districts of Mohave County, Ariz., was completed by F. C. Schrader and is in press as Bulletin 397. In March Mr. Schrader began an investigation of the mineral deposits of the Patagonia and Nogales quadrangles, Arizona, in which he was assisted by J. M. Hill.

A reconnaissance of the geology and mineral deposits in the northern part of Yuma County, Ariz., was made by H. Bancroft.

The Whetstone Mountains, south of Benson, Ariz., were visited by F. L. Hess, for the purpose of studying the tungsten deposits. A brief report on these deposits will be found in Bulletin 380.

At the request of the Supervising Architect of the Treasury Department, an investigation of the marble prospects near Bowie, Ariz., was made, with reference to the geologic conditions which might affect the availability of these marbles for building or decorative purposes. This work was in charge of Sidney Paige, whose report has been submitted.

Geologic mapping in central Texas was placed in charge of A. C. Spencer. The detailed mapping of the complicated pre-Cambrian area of the Llano 30-minute quadrangle was completed and considerable progress was made in the study of the crystalline rocks of the adjoining Burnet quadrangle. In connection with this mapping a careful study has been made of the metallic iron ores of the district. In this work Mr. Spencer has been assisted by Sidney Paige, and during a part of the time by H. Bancroft and F. H. Kay. A brief visit to the region was also made by E. O. Ulrich, for the purpose of assisting in the differentiation of the Paleozoic formations.

In cooperation with the technologic branch David White devoted considerable time to studies of the western coal fields and to collecting material bearing on the origin of certain coals.

Pacific coast.—The field study of the geology and ore deposits of the Goldfield (Nev.) district was completed by F. L. Ransome in July. His detailed report, which was prepared during the winter, is now ready for distribution (Professional Paper 66).

A reconnaissance of the mining regions between parallels 40° and 41° and meridians 117° and 119° was made by Mr. Ransome. This reconnaissance resulted in the preparation of several short reports on the geology and mineral resources of various areas in Nevada. These reports cover the Bullfrog (Bulletin 407); Yerington, Hornsilver, and Round Mountain (Bulletin 380); and Humboldt County (Bulletin 414) districts. In the field work on the Bullfrog district Mr. Ransome was assisted by W. H. Emmons and G. H. Garrey.

A reconnaissance of the mining districts in northeastern Nevada between meridians 116° and 117° and parallels 40° and 42° was made by W. H. Emmons, whose report is nearly ready for publication (Bulletin 408).

A brief examination of the platinum deposits in southern Nevada was made by H. Bancroft, and a study of oil prospects in Nevada by Robert Anderson. Brief reports upon the oil prospects near Reno, in Mason and Smith valleys, and near Palisade were published in Bulletin 381.

Surveys in the oil region of southern California were in charge of Ralph Arnold, assisted by H. R. Johnson. These surveys included the McKittrick, Midway, Sunset, Temblor, Devils Den, and Carrizo Plain districts and adjacent parts of western Kern and eastern San Luis Obispo counties. Special attention was given to the details of the underground geology in the proved territory, in order to discover the laws governing the occurrence of the petroleum in the various fields, and also to a study of the structure and stratigraphy of the adjacent region, with a view to furnishing information as to the extension of the productive area and to decreasing the cost of exploitation by reducing the number of dry holes drilled. A study of the paleontology, which bears a peculiarly important relation to the interpretation of the structure and stratigraphy in this region, was carried on simultaneously with the economic work. A preliminary report on the region has been completed and is in press as Bulletin 406.

The detailed report on the Coalinga oil district, California (Bulletin 398), was completed by Ralph Arnold, assisted by Robert Anderson. The paleontology of this district was made the subject of a special report (Bulletin 396) by Mr. Arnold. Both of these reports are now in press. During the year a report on the sodium sulphate deposits in the Carrizo Plain, by Ralph Arnold and H. R. Johnson, was issued as an advance chapter of Bulletin 380.

On the resignation of Mr. Arnold, June 1, 1909, Mr. Anderson was assigned to continue the investigations of the California oil fields, and field work in the Carrizo Plain region—an undeveloped territory adjoining the McKittrick-Sunset district—was resumed.

Geologic work in the Randsburg quadrangle, California, was prosecuted by F. L. Hess, who gave special attention to the study of the gold deposits of that area.

The report on the copper-mining districts in Shasta County, Cal., is nearing completion. It has been delayed by the resignation, in February, of L. C. Graton, who made the investigations and who had the matter in charge. The work has been taken up by B. S. Butler, and will be pushed to completion as soon as possible.

On June 1, 1909, a detailed study of the iron-ore deposits of southern California was commenced by E. C. Harder and J. L. Rich. This work will be continued during the summer and fall.

The Bohemia mining district of Oregon was examined by D. F. MacDonald, who spent two weeks in a study of the district and made a brief report thereon (in Bulletin 380).

Considerable progress was made by F. C. Calkins and J. T. Pardee in the areal mapping of the Sumpter quadrangle in Oregon. A brief report on the faulting and vein structure in the Cracker Creek mining district, in this quadrangle, was prepared by Mr. Pardee and appeared in Bulletin 380.

Satisfactory progress was made by J. P. Smith on the report on the Upper Triassic of California, Oregon, and Nevada. Field work bearing on this subject was confined to the Blue Mountains of Oregon.

A special reconnaissance of the Grants Pass quadrangle and bordering region in Oregon was made by J. S. Diller, assisted by G. F. Kay. A brief report will be found in Bulletin 380.

National forests.—An important work carried on by the geologic branch is the examination of contested mineral claims in the national forests. This work is under the immediate supervision of Waldemar Lindgren. To it there were detailed during the year a number of geologists as well as temporary assistants. Contested claims in the Cabinet and Black forests were examined and reported on by F. C. Schrader. Claims in the Holy Cross, La Salle, Gunnison, Jemes, Montezuma, Ozark, Pecos, Rio Grande, Taos, Teton, and Leadville forests were examined and reported on by J. M. Hill; claims in the Sawtooth and Snoqualmie forests by E. E. Bugbee; claims in the Rainier forest by E. E. Bugbee and J. B. Umpleby; claims in the Umpqua, Black Hills, and Crater forests by D. F. MacDonald; and claims in the Trinity and Plumas forests by H. W. Turner. In all 131 claims or groups of claims were examined, and reports as to their mineral or nonmineral character were transmitted to the Forest Service. Of the total number of locations examined 76 were recommended to be canceled as nonmineral land.

GENERAL GEOLOGIC AND PALEONTOLOGIC WORK.

T. W. Stanton has had general supervision of the paleontologic work during the year. In order to make this work of the highest possible service it is necessary to bring the paleontologists and geologists into close touch in the field. Hence most of the field work of the paleontologists is done in connection with geologic parties. The paleontologic work is essential not only in connection with stratigraphic, structural, and areal geology, but also with various problems of economic geology. This is notably true of the investigations of oil and coal fields, where the tracing of productive horizons and the correlation of beds from place to place would be impossible without the assistance of the expert paleontologist. In addition to the aid rendered in the field, a large share of the time of the paleontologists during the office season is occupied in the determination of fossil collections submitted by the field geologists. So fully is their time taken by this routine work that little opportunity remains for the general studies and correlations essential for the symmetrical development of the Survey work. Additional assistants in the section of paleontology are urgently needed.

In addition to the supervision of the paleontologic work, Mr. Stanton visited 17 parties in the field in Montana, Wyoming, and Colorado, chiefly engaged in the land-classification surveys, for the purpose of correlating the coal-bearing formations and of studying problems bearing on the late Cretaceous and early Tertiary rocks of the Rocky Mountain region. Field study on the same general problems was resumed by Mr. Stanton early in June.

The study of the stratigraphy and paleontology of the coal-bearing rocks of the Rocky Mountain region was continued in the field and office by F. H. Knowlton, who visited numerous points in Montana, Wyoming, Colorado, and New Mexico, for the purpose of collecting fossil plants and determining the stratigraphy of the coal beds.

Under the joint direction of F. H. Knowlton and C. D. White a compendium of paleobotany is being prepared by Miss C. H. Schmidt, and satisfactory progress is reported.

W. H. Dall has continued during the year his studies on the Tertiary paleontology of the Pacific coast.

The work of the other paleontologists has been noted in connection with the geologic work with which it is intimately related.

Considerable progress was made on the monograph of Cambrian Brachiopoda by C. D. Walcott. The technical descriptions and most of the tables were completed. The chapters dealing with the classification, evolution, and biologic relations of the Brachiopoda were also completed.

A study of graptolite faunas, with special reference to their value in stratigraphic correlation, was made by E. O. Ulrich. This has been found of great service in the classification of shale and sandstone formations in which other classes of fossils are practically absent.

Progress was made on the monographs on Cambrian bivalved Crustacea and on fossil Ostracoda, which are in course of preparation by E. O. Ulrich and R. S. Bassler.

A special monographic study of the Mesozoic and Cenozoic Echinodermata of the United States is being made by W. B. Clark and M. W. Twitchell. In this work particular attention has been given to the geologic distribution of the forms, as an aid in the interpretation of the Cretaceous and Tertiary deposits of the Atlantic and Gulf coastal plains.

The collection of fossils from the celebrated "silex" beds of Florida was greatly augmented during the year. As they are of importance in correlating the Oligocene of the Antilles, a special study is being made of them by W. H. Dall. The results will later be incorporated in a bulletin.

The preparation of the general geologic map of North America, which is being compiled in cooperation with the geological surveys of Canada and Mexico, has been continued by Bailey Willis. The map and accompanying descriptive text are approaching completion. They will be published as a professional paper, entitled "Index to the stratigraphy of North America." In connection with this work studies in paleogeography were carried on, in the course of which fifteen maps of the continent have been drawn to represent its geographic aspect at as many periods, from Lower Cambrian to Quaternary.

During the prosecution of the coal-land surveys in the States of Montana, Wyoming, and Colorado, important stratigraphic data bearing on the late Cretaceous and early Tertiary history of that region were obtained. From these data a general geologic map of the region has been prepared by Bailey Willis.

Studies of the Pleistocene glaciation of the Sierra Nevada were continued by W. D. Johnson, who, in company with G. K. Gilbert and with E. C. Andrews, of the New South Wales Department of Mines, made an excursion to the alpine district of the Sierra, where a joint field study of the mechanics of glacial erosion and the principles of glacial sculpture was conducted.

The catalogue of earthquakes in the United States, which is in charge of H. F. Reid, was during the year augmented by records of some early earthquakes, as well as records of earthquakes which occurred during the year.

A general report on the manganese deposits of the United States was prepared by E. C. Harder, and a bulletin on the economic geology of the feldspar deposits of the United States (Bulletin 420) was completed by E. S. Bastin.

Considerable progress was made in the classification of the physiographic features shown on topographic maps, a study which is being conducted by W. W. Atwood.

A comprehensive geologic exhibit was prepared for the Alaska-Yukon-Pacific Exposition at Seattle. The work of assembling and classifying the exhibit was in charge of J. S. Diller.

The important investigation of problems connected with the overloading of California rivers by mining débris was continued by G. K. Gilbert, in cooperation with the water-resources branch.

WORK OF LAND-CLASSIFICATION BOARD.

The organization of the land-classification board has already been discussed on pages 10–12. The work accomplished by the board to the close of the fiscal year has been as follows:

Coal land.—Soon after its organization the coal section of the board found that it was confronted with many questions which required a decision by the Secretary. The matter was therefore presented to him with the statement that, until he should rule on the questions presented, it was deemed unwise to transmit further classifications. New regulations covering the classification of coal land were approved by the Secretary on April 10, 1909, and classification was immediately resumed.

In these regulations the selling price of the government coal land is fixed on the basis of tonnage and quality of the coal, the rate ranging, except for lignite, from half a cent to 3 cents a ton, about 5 to 30 per cent of the royalties prevailing in the West. This low percentage is adopted in order to allow for the cost of carrying the investment while mining, as opposed to the royalty paid when the coal is mined, and for the extra hazard of a coal-land purchase over that of a lease paying a royalty on coal actually recovered. These unit rates are further reduced where the land contains more than one bed, and these reductions, with allowances for depth and other factors, make the actual price fixed usually less than 10 per cent of royalty prices.

Since the adoption of these regulations 5,155,194 acres of land have been classified with respect to their coal values. Of this total area, 742,573 acres were classified as coal land, and the selling price fixed on this area is approximately $30,000,000, representing an advance over the minimum price fixed by law of more than $16,000,000. Of this land, over 50 per cent belongs to the Government, and if this coal land were leased it would ultimately yield about $150,000,000 instead of the $15,000,000 which will be received by sale.

The area classified is divided among the States as follows:

Coal-land classification under Secretary's regulations of April 10, 1909.

State.	Area in acres.		Total value of coal land at prices fixed.	Total value of coal land at minimum price.
	Coal.	Noncoal.		
Colorado	104,298	331,865	$2,325,330	$2,085,960
Montana	493,931	2,241,210	12,026,847	9,739,919
Wyoming	144,344	1,839,546	16,136,174	2,316,833
	742,573	4,412,621	30,488,351	14,142,712

All coal-land classifications heretofore made by the Geological Survey will be reviewed by the coal section and the lands reclassified.

The results obtained by the 13 parties now surveying the public coal lands will also come to the section for action.

In addition to the above, the coal section has classified 19 coal claims in national forests.

Phosphate.—On December 10, 1908, the Secretary, in aid of proposed legislation covering the disposal of phosphate lands, temporarily withdrew from all forms of disposal the unpatented lands in tracts covering 4,699,160 acres in the States of Wyoming, Idaho, and Utah. These withdrawals were made by the township unit, because of the uncertainty of the location of the phosphate-bearing beds with reference to the smaller legal subdivisions. A review of this withdrawal by the phosphate section of the board led to the restoration of 231,040 acres of nonphosphate lands in areas where the location of the deposits with reference to the land corners was known with sufficient definiteness to warrant such action. It is expected that examination will show that a large per cent of the land now withdrawn is nonphosphate, and the release of such areas will immediately follow the completion of the field work now in progress.

Power sites.—Upon data furnished by the Geological Survey, the Secretary, between May 4 and June 30, 1909, made 26 temporary power-site withdrawals covering rivers in Colorado, Montana, Idaho, Oregon, Utah, and Wyoming. These withdrawals were made in aid of proposed legislation affecting disposal of power sites and resulted in the removal from all forms of disposal and temporary suspension of existing entries, claims, and filings in the following areas:

Power-site withdrawals.

[Acres.]

State.	Entered land.	Vacant land.	Total.
Colorado	360	21,880	22,240
Montana	6,066	39,979	46,045
Idaho	3,402	56,480	59,882
Oregon	5,849	75,269	81,118
Utah	15,200	19,680	34,880
Wyoming	7,754	27,629	35,383
	38,631	240,917	279,548

Other withdrawals are being made as rapidly as data becomes available.

Enlarged homestead designations.—The enlarged homestead act became a law on February 19, 1909, and the first designation under this law was made by Secretary Garfield in eastern Wyoming on March 3, 1909.

The total areas designated in each State up to the end of the fiscal year are given below:

Designations under enlarged homestead law.

	Acres.
Wyoming	10,676,280
Arizona	26,657,280
Colorado	20,299,840
Montana	19,957,960
Nevada	49,512,960
New Mexico	14,808,520
Oregon	8,346,560
Utah	7,044,480
Washington	3,576,960
	160,880,840

Since the passage of the enlarged homestead act 91 petitions have been received. The action taken on these is indicated below:

Enlarged homestead designations in March, April, May, and June, 1909.

Favorably considered	16
Partly refused	21
Refused	12
Pending:	
Field work in progress	16
Under consideration	26

Oil.—The oil section of the board classified 974,820 acres in the McKittrick-Sunset (California) oil withdrawal. Of this area 430,340 acres were classified as oil land.

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under an appropriation of $80,000 for "continuation of the investigation of the mineral resources of Alaska," work of the following classes having been done: Reconnaissance and detailed geologic surveys; special investigations of mineral resources; reconnaissance and detailed topographic surveys; investigations of water resources in reference to supply available for placer mining; and collection of statistics on mineral production.

PERSONNEL.

The personnel of the division varies greatly during the year by transfers of technical employees to and from other divisions of the Survey and by the employment of temporary clerks as the work demands. Throughout the year 1 geologist in charge, 7 other geologists, 3 topographers, and 3 clerks have been employed. In addition to these 1 geologist was employed on annual salary until April 20, when he was transferred to the per diem force; 1 geologist on an annual salary gave about half his time to the Alaska work; and 3 others were employed a part of the time on a per diem compensation. On May 1, 1909, 1 additional geologist on annual salary and 1 topographer on monthly salary were added to the force by transfer from other divisions. Five engineers were detailed to the division from the water-resources branch for varying periods of time.

During the season of 1908 the field force included also 1 topographic and 1 geologic field assistant, together with about 28 teamsters, cooks, etc. The temporary assistants in the field force, as already organized for 1909, include 2 geologic and 2 topographic field assistants, with about 30 laborers. One temporary clerk has been employed in the office for six months and a clerical assistant for short periods of time. On June 30, 1909, the division included 1 geologist in charge, 9 geologists on annual salaries and 5 geologists employed at a per diem compensation, 2 geologic field assistants, 3 engineers, 30 camp hands, and 3 clerks.

FIELD OPERATIONS IN SEASON OF 1908.

Allotments and areas covered.—Thirteen parties were engaged in Alaskan surveys and investigations during the field season of 1908 for varying periods between March and November. Some of these parties were subdivided in the field, making a total of 17 parties that were engaged in various kinds of investigation. The geologist in charge also spent a part of the summer in Alaska, carrying on geologic investigations and visiting field parties.

The area covered by topographic reconnaissance surveys during 1908 aggregated 3,975 square miles; by detailed topographic surveys, 427 square miles; by detailed geologic surveys, 604 square miles; and by geologic reconnaissance surveys, 4,850 square miles. In addition to the actual areal mapping most of the geologists spent considerable time in studying special problems connected with the mineral deposits. The investigation of the water supply in placer districts covered an area of 6,700 square miles and included the maintenance of 53 gaging stations and 556 measurements of stream volumes. Of the 28 mining districts of Alaska that are being developed 18, including all but 3 of the most important, were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. These figures include the cost of both field and office work as well as inspection.

Allotments to Alaskan surveys and investigations, 1908.

Southeastern Alaska	$9,800
Prince William Sound and southwestern Alaska	9,100
Copper River region	20,000
Yukon basin	27,950
Seward Peninsula	13,150
	80,000

The following table shows approximately the amount of money devoted to each class of investigation. It is not possible to give the exact figures, as in some cases the same party, or even the same man, carried on two different kinds of work; but this statement will help to elucidate the later table, which summarizes the complete areal surveys:

Approximate allotment of Alaskan funds to different classes of surveys and investigations, 1908.

Geologic reconnaissance surveys	$14,100
Detailed geologic surveys	10,000
Special geologic investigations	8,900
Topographic reconnaissance surveys	12,200
Detailed topographic surveys	14,200
Investigation of water resources	9,900
Collection of statistics of mineral production	1,500
Miscellaneous, including clerical salaries, administration, inspection, instruments, and office supplies and equipment	9,200
	80,000

The geologic reconnaissance surveys of the above table include all those published on a scale of 1:250,000 to 1:625,000, or approximately 4 to 10 miles to the inch. The detailed geologic surveys are for publication on a scale of 1:62,500, or approximately 1 mile to the inch. The special geologic investigations are chiefly those directed to the study of problems connected with the occurrence of mineral deposits. The topographic reconnaissance surveys are chiefly for publication on a scale of 1:250,000, usually with 200-foot contours, though some exploratory surveys are published on a scale of 1:625,000. The detailed topographic surveys are for publication on a scale of 1:62,500, with 25, 50, or 100 foot contours. The water-resources investigations have for their purpose the determination of the water supply available for placer mining.

The cost per square mile of the various types of surveys is determined by many factors varying greatly in different parts of the Territory. Chief among these is the item of transportation, which ranges in cost from 5 to 30 per cent of the total expenditure for surveys. The cost of the topographic reconnaissance surveys is from $2 to $4 per square mile and of the detailed topographic mapping from $25 to $40 per square mile. The variations are partly due to differences in cost of transportation, but also to character of topography, vegetation, rainfall, length of open season, etc.

All the variations which affect the cost of topographic work also influence that of geologic mapping. In addition there is a more important factor in the knowledge of the characteristics of the geology and of the problems involved, before the work has been begun. If the general features of the geology of any province are known, areal mapping can be carried on much more rapidly there than in an unexplored province. Obviously, also, where the stratigraphic and areal relations are simple mapping can be carried on far more rapidly than where they are complex. It is not surprising, therefore, that the cost of geologic reconnaissance surveys varies from 75 cents to $3.50 per square mile. In Alaska detailed geologic surveys have been carried over only a few small areas, so that there are few data on which to base estimates of cost. The evidence in hand, however, indicates a cost of $14 to $34 per square mile for work of this class. Water-resources investigations, involving the measurement of stream volumes in the same district for a period of years, can not be estimated per square mile.

The following table shows the progress of Alaskan surveys since the beginning of systematic work in 1898:

Progress of surveys in Alaska, 1898–1908.[a]

Year.	Appropriation.	Areas covered (square miles).				Water-resources investigations.	
		Geologic.		Topographic.		Gaging stations maintained part of year.	Stream-volume measurements made.
		Reconnaissance.	Detailed.	Reconnaissance.	Detailed.		
1898	$46,189.60	9,500	....	14,912	....	....	....
1899	25,000.00	6,000	....	8,688	....	....	....
1900	25,000.00	10,000	....	11,152	....	....	....
1901	35,000.00	12,000	....	15,664	....	....	....
1902	60,000.00	17,000	....	20,304	336	....	....
1903	60,000.00	13,000	336	15,008	....	....	....
1904	60,000.00	6,000	....	6,480	480	....	....
1905	80,000.00	8,000	550	8,176	948	....	....
1906	80,000.00	9,000	414	10,768	40	14	286
1907	80,000.00	4,000	400	6,125	501	48	457
1908	80,000.00	4,850	604	3,975	427	53	556
	631,189.60	99,350	2,304	121,252	2,732	....	....
Percentage of total area of Alaska	....	16.94+	0.39+	20.85−	0.47−	....	....

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[a] In addition to the above, the International Boundary Survey and the Coast and Geodetic Survey and other government bureaus have covered an area of approximately 50,000 square miles. Most of this work is along the coast line, and has been carried on with a high degree of refinement. The inland surveys are chiefly of a reconnaissance character, except for a narrow strip along the international boundary.

The progressive decrease in the area covered annually by reconnaissance surveys is largely due to the fact that since 1903 a considerable part of the appropriation has been spent for detailed surveys, in order to meet the growing demand for detailed maps. As the detailed surveys cost from five to twenty times as much as reconnaissance surveys, the total area surveyed for the same money is necessarily very much less. Another reason for the decrease is the fact that during the first five years practically the entire appropriation was devoted to explorations, whereas now much of it is spent on special investigations. Moreover, early exploratory surveys were not executed with the same degree of refinement as the present reconnaissance work.

To meet the demands of the mining industry, it does not seem advisable to devote any larger percentage of the appropriations to reconnaissance surveys at the expense of detailed surveys and investigations, and therefore, with funds available, the general work can not be extended any more rapidly than it has been during the last decade. As approximately a fifth of the Territory has been covered by reconnaissance maps, both topographic and geologic, it appears that it will require at least fifty years to cover the whole Territory with the preliminary mapping. It should be added, however, that the areas that have been chosen for survey are those of most importance to the mining industry, and that a fifth or a quarter of the remaining area may not require survey for many years to come. The fact remains, however, that there are about 200,000 square miles in Alaska which should be surveyed at an early date, and that under the present appropriation it will be impossible in less than two or three decades to accomplish this and at the same time carry on the detailed work demanded by the mining developments.

General investigations.—The field investigations of Alfred H. Brooks, geologist in charge of the division, covered the period from about the end of July till the middle of October. Of the time actually devoted to field work, about two weeks was spent with Mr. Wright on the geology of Kasaan Peninsula, Karta Bay, and the Copper Mountain region—all on Prince of Wales Island. At the same time Mr. Sargent's topographic party, then surveying the Copper Mountain region, was visited. About ten days was spent at Fairbanks with Mr. Covert, Mr. Prindle, and Mr. Katz in becoming familiar with the problems connected with the detailed geology and mining development of the Fairbanks district. The latter part of the season was spent with Mr. Smith in a review of the areal geology of the Solomon and Casadepaga region, together with some reconnaissance work in adjacent areas.

In the office Mr. Brooks has given most of his time to administrative and routine work, in which he was aided by R. H. Sargent, who supervised the Alaskan topographic surveys. During Mr. Brooks's absence in the field E. M. Aten looked after the office work and also rendered valuable services in the compilation of the mineral statistics of Alaska. Most of the month of July was devoted by Mr. Brooks to a continuation of the report on the Mount McKinley region. During the month of December he prepared a summary of the existing knowledge of the mineral resources of Alaska for the Conservation Commission. He also prepared a report entitled "Mining and mineral wealth of Alaska" for distribution at the Alaska-Yukon-Pacific Exposition and a report on the gold, silver, and copper production of Alaska for the "Mineral resources" volume of 1908.

By instructions of the Secretary of the Interior Mr. Brooks prepared a comprehensive scheme for subdivisional surveys in Alaska, reporting that there was a great need for additional land surveys in the Territory. He also prepared a plan for an agricultural reconnaissance of Alaska, which was approved by the Secretary of Agriculture, and Mr. Brooks was thereupon called into conference by the Chief of the Bureau of Plant Industry for consultation on the best methods of carrying out such survey. Realizing the desirability of educating the public on the physical features and resources of Alaska, Mr. Brooks suggested to Secretary Walcott, of the Smithsonian Institution, the wisdom of installing a special Alaska exhibit, and at Mr. Walcott's request he outlined a plan for such an exhibit.

Mr. Sargent devoted about four months to the preparation of an exhibit for the Alaska-Yukon-Pacific Exposition. This exhibit included 10 large maps and about 20 small ones showing the geology and mineral resources of Alaska, a large number of photographs and transparencies illustrating methods of mining in the Territory, a complete set of Survey publications relating to Alaska, and a set of about 600 specimens of typical rocks, ores, and minerals. Mr. Sargent was assisted in this work by P. S. Smith, who devoted about six weeks to it, and by other geologists for shorter periods of time. Five draftsmen were employed for periods of one to four months in preparing the maps, their salaries being met by allotment from the federal appropriation for the Alaska building. The preparation of this exhibit seriously interfered with the regular work of the division, and as a consequence two maps and two reports which under ordinary circumstances would have been finished before the field season opened had to be left over until next winter.

Southeastern Alaska.—The detailed geologic mapping of Kasaan Peninsula and the copper-bearing belts of Copper Mountain begun in 1907 was completed in 1908 by C. W. Wright. About 90 square miles have been mapped. These investigations represent the first detailed studies made south of Juneau and form a part of the general plan to make similar studies of all the important producing mining districts. The base maps needed for this detailed geologic work were begun in 1907 by D. C. Witherspoon and were completed in 1908 by R. H. Sargent, who also mapped an area of 53 square miles in the Copper Mountain region. These surveys were made for a publication scale of 1 inch to a mile (1:62,500) with 50-foot contours.

Copper River region.—F. H. Moffit, associated with Adolph Knopf and assisted by S. R. Capps, in 1908 made a reconnaissance survey of the copper and gold bearing belt extending from the head of Copper River across to White River. About 1,800 square miles have been mapped geologically and Mr. Capps, who devoted about one month to topographic surveys, covered an area of 450 square miles.

As detailed study of the copper deposits of this general province must be undertaken before the laws of their occurrence can be determined, and as such detailed studies require a base map, it was decided to prepare such a map of the east end of the Kotsina-Chitina belt. To this work D. C. Witherspoon, assisted by R. M. La Follette, was assigned and surveyed an area of 325 square miles for publication on a scale of 1 mile to the inch, with contour intervals of 50 feet.

Prince William Sound.—The Prince William Sound region has been the scene of several investigations by the Geological Survey, the latest previous to 1908 having been made by U. S. Grant in

1905. The extensive prospecting done in this field and the fact that it has been a large shipper of copper ore made further work imperative. Mr. Grant assisted by D. F. Higgins, was therefore engaged to continue his investigations of this field and to complete the general reconnaissance of the ore deposits of Prince William Sound. The party made geologic reconnaissance surveys of about 600 square miles and a detailed topographic and geologic map of 8 square miles at the north end of Latouche Island. At the close of the season Mr. Grant also made a hasty examination of some of the ore deposits near Seward, on Kenai Peninsula.

Southwestern Alaska.—The general study of the coal fields of Alaska, which was commenced in 1906, was continued during 1908 by a reconnaissance survey of the coal fields of Alaska Peninsula. This work was in charge of W. W. Atwood, assisted by H. M. Eakin. Topographic and geologic reconnaissance surveys of the more important parts of the Herendeen Bay, Unga Island, and Chignik coal fields were made. The total area surveyed was about 1,500 square miles.

Yukon basin.—Last year a topographic survey was made of the Fairbanks placer district for the purpose of obtaining a base map for detailed geologic studies. These studies were carried on this year by L. M. Prindle, assisted by F. J. Katz. They completed the geologic survey of the area covered by the base map (436 square miles) and made a detailed study of the occurrence of auriferous gravel.

To J. W. Bagley was assigned the task of completing the topographic reconnaissance map of the region lying north of and adjacent to Tanana River. He carried a survey eastward along the north side of the Tanana as far as the mouth of Healy River. The latter part of the summer was devoted to topographic mapping near the mouth of the delta, south of Tanana River. In all, an area of 1,725 square miles was covered.

The investigation of the water resources of the Yukon-Tanana district, begun in the Fairbanks region in 1907, was extended by C. C. Covert, assisted by C. E. Ellsworth, in 1908. For the purpose of obtaining data regarding the spring run-off when the melting of the snow takes place in March Mr. Covert proceeded to Fairbanks over the ice. He devoted the early part of the season to a study of the water conditions of the streams tributary to the Chatanika and later proceeded overland to the Circle district, where he met Mr. Ellsworth and party, who came inland by way of White Pass. The balance of the season was devoted to stream gaging in the Circle, Fairbanks, and Baker regions. Twenty-one gaging stations were maintained during the whole or part of the season and 273 measurements of stream volume were made. This work furnishes data in regard to the run-off of about 4,690 square miles.

The great influx of prospectors into the Innoko and lower Yukon region led to a demand for a survey of that district. As funds were not available for a large party, it was decided to make a preliminary examination of the region. This work was intrusted to A. G. Maddren, who spent about a month in examining the creeks tributary to the Yukon reported to be auriferous. He then proceeded to the Innoko and spent the remainder of the season in this field. His work included the making of a sketch map of the region visited, by means of a rough triangulation and foot traverses. A general knowledge of an area including about 1,000 square miles was thus obtained.

Seward Peninsula.—The geology of Seward Peninsula is exceedingly complex, and though its general features have already been determined and the results published, progress has been but slow in deciphering the details of structure and stratigraphy. These problems have an important bearing on the distribution and occurrence of the mineral deposits, especially of metalliferous lodes.

During 1908 two parties were engaged in detailed stratigraphic studies in this region. One of these, in charge of P. S. Smith, spent the summer in completing the detailed mapping of the Casadepaga quadrangle, in continuing the stratigraphic studies of the Kigluaik Mountains, and in making a reconnaissance across the Bendeleben Mountains, 90 square miles being mapped in detail and 150 square miles in reconnaissance.

The stratigraphy of the northwestern part of the peninsula was the subject of investigations by E. M. Kindle, assisted by R. D. Mesler. In connection with this work Mr. Kindle also made a trip to Cape Lisburne and Point Hope for the purpose of establishing stratigraphic correlations.

The investigation of the water resources of Seward Peninsula, so far as they refer to placer mining, was begun in 1906 and continued through 1907 and 1908. In 1908 the work was in charge of F. F. Henshaw, assisted by A. T. Barrows, and observations were continued at some of the gaging stations in the Nome district and also at those established in the Kougarok district. Other stations were maintained in the Iron Creek district, the upper Casadepaga basin, and the Solomon region. In July Mr. Henshaw extended the work into the Fairhaven district, where observations were continued up to the close of the season. These investigations throw light on the available water supply in about 2,000 square miles of the more important placer districts of the peninsula. During the field work 273 measurements of stream volume were made and 21 gaging stations maintained.

Collection of statistics.—The work of collecting statistics from the operators, begun three years ago, was continued through 1908. It is gratifying to note that the operators are showing an increased interest in this work and that most of the large producers are now furnishing the desired information in regard to production. Though the statistical data are by no means yet complete, it is hoped that within another year the figures of production from every important operation may be procured for the purpose of making up the totals. During 1908 the operators of practically every lode mine in the Territory furnished the statistical data requested. There are still many placer miners who have neglected to reply to the inquiries, which are of necessity sent by mail. It is expected, however, that as soon as these men fully realize the purpose of collecting the data and understand that the individual returns are carefully guarded from the public they will be willing to cooperate.

FIELD OPERATIONS FOR SEASON OF 1909.

Under the increased appropriation of $90,000, fourteen parties were dispatched to Alaska during the months of March, April, May, and June. One of these parties is carrying on detailed topographic surveys in southeastern Alaska. Another is doing detailed geologic work in the same region. Another is engaged in making a detailed geologic survey of the Nizina copper-bearing region. A geologic reconnaissance survey of the eastern part of the Kenai Peninsula has also been begun. Two other parties are making a detailed topographic survey of the Matanuska coal field. Two parties have begun a topographic and geologic reconnaissance survey of the Iliamna Lake region. Geologic reconnaissance surveys in the Yukon-Tanana region are being continued. Further investigation of the water resources of the Fairbanks, Birch Creek, and Rampart region is being made. A party is also engaged in making an exploratory survey from Nulato, on the Yukon, to Council, in Seward Peninsula. The survey of the Koyukuk and Chandalar placer district made in 1899 is being extended. In Seward Peninsula two men are engaged in continuing the reconnaissance of the water resources available for placer mining. Mr. Brooks left Washington on June 24 en route to Copper River and Fairbanks.

OFFICE WORK.

During the fiscal year five bulletins have been issued, and there are in press one water-supply paper and one professional paper, all embodying results of the work of the Alaska division. In addition to these reports, which contain maps, one general map of Alaska and one detailed topographic map of the Controller Bay region have been issued as sale publications.

The following manuscripts were submitted for publication in May and June: "The Nabesna-White River copper region," by F. H. Moffitt and Adolph Knopf, including geologic and topographic reconnaissance maps (Bulletin 417); "Geology of the Solomon and Casadepaga quadrangles," by P. S. Smith, including detailed geologic map; "The geology and mineral resources of the Prince William Sound region," by U. S. Grant, including geologic reconnaissance map; "The Yakutat Bay earthquake, September, 1899," by R. S. Tarr and Lawrence Martin; "The Innoko gold-placer district, with accounts of the central Kuskokwim Valley and the Ruby Creek and Gold Hill placers," by A. G. Maddren, including geologic and topographic reconnaissance maps (Bulletin 410). The reconnaissance maps of the Fairbanks and Rampart quadrangles have also been submitted for issue as sale publications.

The following reports are in hand: "Geology and mineral resources of the Nome and Grand Central quadrangles," by F. H. Moffit and P. S. Smith (75 per cent completed, held for further field work); "Geology of the Fairbanks district," by L. M. Prindle (75 per cent completed, held for further field investigations); "Geology and mineral resources of parts of the Alaska Peninsula," by W. W. Atwood (10 per cent completed); "An exploration in the Mount McKinley region," by Alfred H. Brooks and L. M. Prindle (90 per cent completed); "Geology and ore deposits of Kasaan Peninsula and Copper Mountain region, Prince of Wales Island," by C. W. Wright (60 per cent completed.) The maps in hand are as follows: Nizina special, scale 1:62,500 (completed); Circle quadrangle, scale 1:250,000 (95 per cent completed); Upper Tanana quadrangle, scale 1:250,000 (40 per cent completed); Copper Mountain special, scale 1:62,500 (75 per cent completed); Kasaan Peninsula, scale 1:62,500 (75 per cent completed).

GEOLOGIC RESULTS.

Among the most important results of the last season's work are the definite proof of the presence of Cambrian rocks in Seward Peninsula, by E. M. Kindle, and the finding of a marine Eocene fauna in association with plant-bearing beds of the Kenai formation on Alaska Peninsula, by W. W. Atwood and E. M. Eakin. Mr. Grant and Mr. Higgins procured definite proof of the unconformable relations between the Valdez and Orca groups of rocks, and the subdivision of the Orca group into formations is an important fact bearing on the geology of Prince William Sound and the adjacent area. In the upper White River region Mr. Moffit and Mr. Knopf proved the Mesozoic age of the intrusive rocks, thus establishing synchroneity with the granites of the Coast Range. They also showed two types of mineralization; in the one native copper occurs in an amygdaloidal greenstone similar to that of the Chitina Valley; in the other gold and copper ores are found in association with Mesozoic intrusive rocks and are similar in character to the mineral occurrences of southeastern Alaska. Mr. Maddren's work shows a southwestern extension of the Paleozoic and metamorphic rocks of the Yukon-Tanana region into the Innoko and Kuskokwim valleys. The results of the investigations of the Yakutat Bay earthquake of September, 1899, completed during the year, are of far-reaching geologic significance. The surface dislocation produced by the earth's movement is one of the most extensive which has ever been measured.

DIVISION OF MINERAL RESOURCES.

The preparation of reports on the mineral resources of the United States is carried on in the division of mineral resources under an appropriation of $75,000, and in accordance with the organic law of the Survey, which includes a provision that the Geological Survey shall examine the "mineral resources and products of the national domain."

The first of these annual reports was published in 1883 and covered the calendar year 1882. The volume is an annual statistical compilation, but it also contains discussions of the occurrence, development, and uses of the mineral products, the object being to make it a complete compendium of the country's mineral resources. Each annual report covers a calendar year and must therefore necessarily be distributed through two fiscal years.

The report for 1907 was completed, published, and distributed in January, 1909. The report for 1908 was prepared in part, twenty chapters having been completed before the close of the fiscal year 1908-9 and submitted for publication in advance of the volume. The chapters completed and distributed to the public are as follows: Bauxite and aluminum; monazite and zircon; phosphate rock; salt and bromine; and slate. Those submitted for publication but not yet issued are as follows: Asbestos; barytes and strontium; cement; chromic iron ore; fluorspar and cryolite; silver, copper, lead, and zinc in the Central States; gypsum; manganese ores; mica; petroleum; quartz (flint) and feldspar; sand-lime brick; sulphur and pyrite; talc and soapstone; and tin. At the close of the previous fiscal year the manuscript of seventeen chapters had been completed and transmitted for publication.

During January and February preliminary statements of production in 1908, with a review of the conditions prevailing during the year, were given to the press in the form of special bulletins for the following subjects: Gold and silver mining in the United States; copper, lead, and zinc production; the cement industry; a review of the coal-mining industry; and petroleum.

A considerable part of the time of the experts employed in this division is consumed in answering technical inquiries and making visual examinations of mineral specimens that are submitted by numerous persons for determination. Inquiries for information as to the character of ores are answered as promptly as possible, and such information is given freely where a chemical analysis or assay is not required.

Since August, 1907, the work of the division has been carried on under the supervision of Edward W. Parker, statistician in charge. At the same time Waldemar Lindgren was placed in charge of the section relating to metalliferous statistics (except iron).

Mr. Parker, in addition to his duties as administrative officer, prepares the reports on the production of coal and the manufacture of coke. D. T. Day continues with the division as expert in charge of the work on petroleum. The preparation of the report on the clay-working industries is carried on under the supervision of Jefferson Middleton. E. C. Harder, junior geologist, supervises the reports on production of iron and manganese, and E. F. Burchard, assistant geologist, has charge of the reports on building stones and other structural materials, the intention being to cooperate with the division of geology and the technologic branch, so as to make the reports on these products comprehensive studies of their occurrence, utilization, and markets. F. B. Van Horn, assistant geologist, has charge of the work on phosphate rock and fuller's earth, and the following members of the Survey have been designated to prepare reports on the minor but at the same time important mineral substances: J. S. Diller, asbestos and talc and soapstone; W. C. Phalen, abrasive materials, aluminum and bauxite, bromine, grindstones and whetstones, salt, sodium salts and potash, and sulphur and pyrite; J. A. Taff, asphaltum and bituminous rock; E. S. Bastin, flint and feldspar and graphite; D. B. Sterrett, mica, monazite and zircon, and precious stones; Samuel Sanford, mineral waters; C. A. Davis, peat.

In the metalliferous statistics section, under the charge of Waldemar Lindgren, assisted by H. D. McCaskey, C. E. Siebenthal, F. L. Hess, and B. S. Butler, statistics of the annual production of all metals, except iron, are collected. Three local offices are maintained in Denver, Salt Lake, and San Francisco, in charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, respectively, whose duty it is to collect data of mine production by direct correspondence with the producers. Reports were issued on the production of gold, silver, copper, lead, zinc, quicksilver, platinum, tungsten, tin, arsenic, antimony, and a number of rarer metals. The reports on the more abundant metals are issued in two forms. The first contains what are termed the smelter reports, based on actual production of metals as reported by the smelters. The second, which is termed the mine report, is based on the returns from the individual mines and contains an epitome of the mining operations and output by quantity of metal and tons of ore of all the more important mining camps in the country. This service, which has been in operation since 1904 for the Western and Eastern States, was extended during the last fiscal year so as to include the Central States. Thus the volume "Mineral resources" contains, in addition to the figures of actual smelter production, a summary of the condition of the metal industry throughout the United States. Preliminary statements of the production of copper, lead, and zinc in 1907 were issued in July, 1908. The detailed mine reports were, unfortunately, somewhat delayed by the vast amount of material to be gathered and were not issued until late in the fall. On January 1, 1909, preliminary statements were issued as to the approximate production in 1908 of copper, lead, and zinc, and also, in conjunction with the Bureau of the Mint, of gold and silver. The smelter production of zinc was made public in April, and the production of copper and lead was announced in final figures at the beginning of June. The report for 1907 contains a map of the mining districts of the United States, which is believed to be a useful addition to the volume.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

The work of the chemical laboratory was seriously crippled by the fire which occurred in the Survey building on December 18, 1908. Although the fire barely touched the laboratory itself, it invaded the corridor leading to the laboratory, destroyed the ventilating plant, and injured the cases containing chemicals and apparatus. The inevitable delays incurred in making the necessary repairs seriously interfered with the work of the laboratory for nearly four months. In all 119 quantitative analyses were reported during the year and 652 qualitative determinations were made.

The personnel of the laboratory has undergone some change. W. F. Hillebrand and E. C. Sullivan resigned from the Survey, to accept positions elsewhere. The vacancies thus created were filled by the appointment of R. C. Wells and Chase Palmer.

Routine work in the laboratory has necessarily followed well-established lines. As in previous years, much of it has devolved on George Steiger and W. T. Schaller. The analyses made have covered the usual ground, and with the following exceptions have shown nothing particularly novel. A telluride and sulphide of antimony, copper, and bismuth was discovered by Chase Palmer in material sent in from the Goldfield (Nev.) district, and a new titanite of iron in material received from Arizona. These minerals are still under investigation.

Some time has been given by F. W. Clarke to the recalculation of the atomic weights. He has also completed the preparation of a bulletin containing the analyses of rocks and minerals made by the Survey laboratory to January 1, 1909. This volume (Bulletin

419), which is now in the hands of the editor, contains more than 2,400 analyses. A résumé of the chemical work of the Geological Survey was also prepared by Mr. Clarke for the International Congress of Applied Chemistry which was held in London on May 31.

Investigations relative to the formation of metallic sulphides have been conducted by R. C. Wells, the hydrolysis of the sulphates of iron being particularly studied.

The sodium-potassium ratio in Ohio River water was determined by Mr. Palmer, thus completing the study of this ratio in typical rivers of the United States. Mr. Palmer also devoted some time to ascertaining the solubility of silica in various organic compounds.

A monographic report on the minerals of the tourmaline region of southern California is in preparation. Some of the material forming the basis of this report was destroyed by fire, but has been replaced by Mr. Schaller, who visited the region for that purpose.

The report on the mercury minerals of Terlingua, Tex., by Messrs. Hillebrand and Schaller has been completed and is in press as Bulletin 405.

For several weeks during the spring M. F. Conner, a chemist from the Canadian Geological Survey, occupied a desk in the laboratory for the purpose of becoming better acquainted with the methods used by this bureau.

In the physical laboratory the experiments on the elasticity of metals at high temperatures have been continued throughout the year under the direction of C. E. Van Orstrand. Preliminary investigations on the diffusivity of solids, sufficient to establish the proper method of procedure, have been completed. Some work has also been done preliminary to an investigation into the formation of rock cleavage. This investigation is to be conducted in cooperation with F. E. Wright, of the Carnegie Institution.

Researches on geophysical problems were continued by G. F. Becker, chief of the division. He also prepared a paper (Bulletin 401) on the relations between local magnetic disturbances and the genesis of petroleum.

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch remained the same as at the close of the last fiscal year, and is as follows:

Chief geographer, R. B. Marshall.
Atlantic division, Frank Sutton, geographer in charge.
Central division, W. H. Herron, geographer in charge.
Rocky Mountain division, E. C. Barnard, geographer in charge.
Pacific division, T. G. Gerdine, geographer in charge.

Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and F. E. Matthes, topographers.

PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 33 junior topographers, 5 assistant topographers, and 34 draftsmen. It was reduced by 11 through death, transfers, and resignations. With these changes, it now includes a chief geographer, 9 geographers, 44 topographers, 48 assistant topographers, 48 junior topographers, and 31 draftsmen. Eight topographers and 5 assistant topographers are on leave without pay. In addition to the above, 175 technical field assistants were employed during a whole or a part of the field season.

SUMMARY OF RESULTS.

The condition of topographic surveys to July 1, 1909, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 23,831 square miles, making the total area surveyed to date in the United States 1,074,957 square miles, or about 35½ per cent. In addition, 11,200 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 35,031 square miles.

Triangulation stations to the number of 157 were occupied, of which 121 were permanently marked; and in addition 13 points were located by intersections. There were run 2,121 miles of primary traverse, in connection with which 256 permanent marks were set. In the course of this work 22,700 square miles were covered by primary control.

In connection with these surveys 6,597 linear miles of primary levels and 470 miles of precise levels were run, making the total amount of primary and precise spirit leveling done since the authorization of this work by Congress, in 1896, 219,216 miles.

The area covered by topographic surveys in Alaska during the fiscal year 1908–9, as reported in detail on pages 47–55, was about 4,402 square miles—427 for publication on the scale of 1:62,500 and 3,975 for publication on the scale of 1:250,000.

The results of primary triangulation and primary traverse in all States in which field work was in progress during the years 1906, 1907, and 1908 were summarized and prepared for publication as a bulletin.

[illegible] appropriate for official reports has also been made the [illegible] publications. Such publications are ordinarily [illegible] results in a more technical form and are usually [illegible] members of the Survey without compensation.

The progress of geologic mapping during the year, as represented [illegible] of the Survey, is shown on Plate I.

DIVISION OF GEOLOGY AND PALEONTOLOGY.

PERSONNEL AND ORGANIZATION.

The scientific force at the beginning of the year consisted of [illegible] geologists and paleontologists, 48 assistant geologists, and 31 junior geologists. During the year there were 13 resignations and [illegible] appointments. Of the total number on the rolls, 86 were continuously employed, 27 gave only a portion of their time to Survey work, [illegible] 17 were not employed during the year. In addition to the [illegible] regular force, 45 temporary field assistants were employed for [illegible] tion of the year.

For purposes of scientific supervision, to which [illegible] added direct administrative control, the work of [illegible] organized under a number of sections, viz:

Areal and structural geology, Arthur Keith in charge.
Paleontology and stratigraphic geology, T. W. St[illegible]
Economic geology, metalliferous ores, Waldemar [illegible]
Economic geology, fuels, M. R. Campbell in charge.
Land classification, A. C. Veatch in charge.

The functions of the section chiefs include [illegible] and supervision of field and office work as well [illegible] of results. They are directly responsible for [illegible] work up to a high scientific standard.

FIELD WORK BY THE CHIEF GEOLOGIST.

During July, 1908, the chief geologist [illegible] sas, Oklahoma, and New Mexico. He [illegible] the geologic conditions at the site of [illegible] dam, at the request of the Reclamation [illegible] a party in Tennessee and made a brief [illegible] tions in the Louisiana oil fields where [illegible] tion with the State Survey. In N[illegible] State geologists and mining engineers [illegible] in connection with the preparation [illegible] of the United States. In March [illegible] fields of Mexico for the purpose [illegible] in [illegible] directing work [illegible] In [illegible] the oil fields of [illegible]

GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

New England.—In Maine cooperative geologic work was continued under the supervision of E. S. Bastin. The mapping of the Eastport quadrangle was conducted by Mr. Bastin, assisted by C. L. Breger, the paleontologic studies being made by H. S. Williams. The preparation of this folio was well advanced.

Some additional work was done in the Frenchmans Bay quadrangle by C. W. Brown.

A report on the peat deposits of Maine (Bulletin 376) was completed by E. S. Bastin in cooperation with C. A. Davis, of the technologic branch, and considerable progress was made on a report on the pegmatites of Maine by Mr. Bastin.

The report on the fauna of the Chapman sandstone of Maine was nearly completed by H. S. Williams.

The inspection of the granite quarries of Connecticut was completed by T. N. Dale, and his report thereon is nearly finished. Mr. Dale also made considerable progress on the Mettawee, Fort Ticonderoga, and Fort Ann folios. In the spring he was transferred temporarily to the technologic branch, for the purpose of inspecting materials for eight government buildings in Massachusetts, Connecticut, and Rhode Island.

The text to accompany the general map of Massachusetts and Rhode Island, which has been prepared on a scale of 4 miles to the inch, was completed by B. K. Emerson. A preliminary map of the Keene (N. H.) and Warwick (Mass.) quadrangles was also prepared by Professor Emerson, and the maps and text covering the eastern half of the Housatonic quadrangle were completed and submitted for publication.

The survey of the surficial geology of the Taconic quadrangle, in Massachusetts, was substantially completed by F. B. Taylor.

In Vermont a field study of the stratigraphy and structure of the north end of the Taconic Mountains and adjacent areas was made by Arthur Keith, E. O. Ulrich, and T. N. Dale. Reconnaissances were also made by Mr. Keith in the Burlington, Middleburg, and Rutland quadrangles, particularly with reference to the structure of the Green Mountains. In these reconnaissances special consideration was given to the Ordovician and Cambrian limestones.

Considerable time has been devoted by Arthur Keith and others to general studies of the geology of Massachusetts and Vermont, with special reference to correlating the work of the different geologists in the New England field. This work will be supplemented during the coming year.

Atlantic and Gulf coastal plains.—In cooperation with the various state geological surveys, the studies of the Atlantic and Gulf coastal plains were continued throughout the year. W. B. Clark was in charge of the investigations in the northern part of the area and T. W. Vaughan in charge of those in the southern part of the area. In addition to office supervision, Messrs. Clark and Vaughan from time to time made visits to various districts for the purpose of studying some special features, with the view of correlating so far as possible the work in the different States. Under their direction a general survey of the geology and underground waters of the coastal plain of Virginia has been made by B. L. Miller, E. W. Berry, and Samuel Sanford. A similar survey of the coastal plain of North Carolina has been made by B. L. Miller and L. W. Stephenson. Special reports on these surveys are practically completed. They will be published as bulletins of the North Carolina and Virginia state geological surveys.

The greater part of the field work for the report on the coastal plain of Georgia has been completed, by L. W. Stephenson on behalf of the Federal Survey and by Otto Veatch on behalf of the Georgia Geological Survey. The report on the stratigraphy and underground waters of Florida, by G. C. Matson and Samuel Sanford, has been completed and submitted. It will be published as a bulletin of the Florida Geological Survey. The data accumulated in regard to the stratigraphy and underground waters of South Carolina will be utilized in a report, now in preparation, by the state geologist, Earl Sloan.

In addition to the general surveys above mentioned, the detailed survey of the Choptank quadrangle in Maryland was completed by B. L. Miller and H. P. Little, and the report is now in preparation. Considerable progress was also made in the detailed survey of the Tolchester quadrangle in Maryland and of the Elkton and Wilmington quadrangles in Delaware and Maryland.

A report on the geology of Long Island was completed and submitted by M. L. Fuller. A special study of the Lower Cretaceous formations of Delaware and Maryland was made by Arthur Bibbins, E. W. Berry, and H. P. Little.

In the study of the fossils, which play an important part in deciphering the stratigraphy of the Coastal Plain, valuable assistance has been rendered by Miss Julia A. Gardner, of Johns Hopkins University, and Dr. R. S. Lull, of Yale University.

Along the Gulf coast the work has included the preparation of a report in cooperation with the State on the geology of the Caddo oil fields of northwestern Louisiana, by G. D. Harris, state geologist, and a report on the geology and underground waters of the coastal plain of Texas east of Brazos River and south of Jefferson, by Alexander Deussen. This study is now being extended to the region of Brazos River.

Northern Appalachian region.—The Ordovician rocks on the west flank of the Adirondack uplift were studied by E. O. Ulrich, in association with H. P. Cushing and Rudolph Ruedeman, of the New York State Survey, and H. M. Ami, of the Canadian Survey. Instructive sections of the Ordovician in Rensselaer County, N. Y., were also studied by Mr. Ulrich and Doctor Ruedeman. One of the results was the acquirement of important data bearing on the stratigraphic relations of the horizons containing graptolite faunas.

Geologic mapping in Pennsylvania was conducted in cooperation with the State, which made an appropriation of $4,500 for the purpose. The work was in charge of G. H. Ashley, who was assisted by Charles Butts, M. J. Munn, E. W. Shaw, W. C. Phalen, and E. F. Lines.

A progress report reviewing the geology of all the quadrangles studied by this Survey in cooperation with the State was prepared by Mr. Ashley, assisted by Messrs. Butts, Munn, and R. W. Stone. This report has been published as a bulletin of the State Survey.

The areal and economic survey of the Hollidaysburg quadrangle, Pennsylvania, was finished by Charles Butts, and the resulting maps and folio text were carried nearly to completion. Mr. Butts also spent several weeks in the Barnesboro and Patton quadrangles studying recent mining developments and ascertaining their bearing on obscure geologic features in that region.

The survey of the Foxburg quadrangle was completed by E. W. Shaw, and the maps and text for the Foxburg-Clarion folio were prepared for publication. The survey of the Burgettstown quadrangle was also carried to completion by Mr. Shaw, and the text of a folio on the Burgettstown and Carnegie quadrangles was practically finished.

The preparation of the Johnstown folio, by W. C. Phalen, was completed. Mr. Phalen also prepared a special economic report on the mineral resources of this quadrangle.

The survey of the Sewickley quadrangle, by M. J. Munn, was finished, and the texts for a folio and an economic bulletin on that quadrangle were submitted. A bulletin on the economic resources of the Carnegie and Clarion quadrangles was also completed by Mr. Munn. The economic bulletins on the Sewickley and Clarion quadrangles will be published by the State.

The text for the Claysville folio is nearly finished, and work has been started in the Pittsburg, New Kensington, and Freeport quadrangles.

An investigation of the mineral-paint ores of eastern Pennsylvania was made by B. L. Miller and E. F. Burchard, assisted by four senior students of the Lehigh University. An abstract of the results of this work will be found in the report on the production of mineral paints in 1908. A more detailed report, which is now completed, will be included in the next annual economic bulletin.

The survey of the Gettysburg quadrangle was completed by G. W. Stose. The results of the survey of this quadrangle will be combined with those for the adjoining Fairfield quadrangle, to be surveyed during the present season, as a single folio.

The maps and text for the Pawpaw-Hancock (W. Va.-Md.-Pa.) folio were nearly completed by Mr. Stose, and that folio will soon be ready for publication.

Progress was made in the areal and economic survey of the Phoenixville and Honeybrook quadrangles, Pennsylvania, by Florence Bascom. This survey will be combined with that of the Reading and Boyertown quadrangles to furnish the material for one folio of the geologic atlas.

The survey of the crystalline formations of the Wilmington, West Chester, Coatesville, and Elkton quadrangles, covering parts of Pennsylvania, New Jersey, and Delaware, was completed by Miss Bascom.

Paleobotanic and stratigraphic studies were made by David White in the coal fields of the Beaver Falls quadrangle, Pennsylvania, and in the Short Mountain Pocono region of West Virginia. Preliminary reports embodying the results were submitted to the geologists in charge of the mapping.

The field survey of that portion of the Easton quadrangle, Pennsylvania, which lies west of Delaware River was completed by W. S. Bayley.

In cooperation with the New Jersey Geological Survey, Professor Bayley made a special study of the magnetite iron ores of New Jersey. His report will be published as a bulletin of the State Survey.

Considerable progress was made by Professor Bayley in the preparation of his report on the crystalline rocks and the economic resources of the Highlands area in the Raritan quadrangle, New Jersey.

A reconnaissance survey of the iron ores of the Appalachian region in Virginia was made by E. C. Harder, whose report will be found in Bulletin 380.

Southern Appalachian region.—The study of the iron ores of the Birmingham district, Alabama, was completed during the year, and the report, by Charles Butts, E. F. Burchard, and E. C. Eckel, is now in press as Bulletin 400. The maps and text for the Birmingham folio were also practically completed by Mr. Butts.

The areal and economic survey of the Brookwood quadrangle, Alabama, was carried nearly to completion by Mr. Butts, and considerable progress was made in the preparation of the maps and folio text. These can not, however, be completed until the new topographic base map is finished.

gulation control for the Madison, Peytona, and Montgomery quadrangles was established by R. H. Chapman, P. W. McMillen, Geo. T. Hawkins, and C. B. Kendall, 12 stations being occupied and 11 permanent marks set. E. L. McNair, Oscar Jones, R. C. Seitz, and C. P. McKinley also secured triangulation control for the Holden, Gilbert, Logan, Matewan, Williamson, Welch, Iaeger, Bald Knob, Mullen, Pineville, Pocahontas, and Eccles quadrangles, in Mingo, Logan, Boone, Mercer, Wyoming, Raleigh, and McDowell counties, 25 stations being occupied and 25 permanent marks established.

OFFICE WORK.

The drafting of the following sheets was completed: Watertown, Stony Creek, and Bath, N. Y.; York, Bellefonte, Bedford, Fairfield, New Kensington, and Zelienople, Pa.; Middletown, Md.; Gassaway, Clay, Montgomery, Fayetteville, and Sutton special, W. Va.; Coahoma, Jonestown, Dundee, and Walnut Lake, Miss.; Montevallo, Ala.; Virgilina district, Va.; Beaufort and Granville counties, N. C.; Gold Hill and Cid districts, N. C.; Brookwood revision, Ala. The adjustment and drawing of maps of the following counties was completed in cooperation with the Bureau of Soils: Lamar, Henry, Bibb, and Autauga, Ala.; Thomas and Grady, Ga.; Bienville and East and West Carroll parishes, La.; Monroe, Miss.; Robeson, N. C.; Center, Pa.

Progress in the drafting of additional sheets was made as follows: Ellsworth, Me., 77 per cent; Delhi, N. Y., 78 per cent; Neversink and Monticello, N. Y., each 80 per cent; Butler, Pa., 25 per cent; Taneytown, Md., 36 per cent; Peytona and Madison, W. Va., each 85 per cent; Pikeville, Tenn., 55 per cent; Lula and Hollywood, Miss., 88 per cent; Clarksdale, Miss., 72 per cent; Lake Cormorant, Banks, Sabino, Robinsonville, Moon Lake, and Lambert, Miss., each 66 per cent; Pritchard, Miss., 55 per cent; Crenshaw, Miss., 52 per cent; Tunica, Miss., 45 per cent; Belen, Miss., 42 per cent; Friars Point, Miss., 32 per cent; Sherard, Miss., 22 per cent; Norfolk, Miss., 20 per cent; Sledge, Miss., 17 per cent; Tibbs, Miss., 10 per cent; Helena, Miss., 8 per cent.

The following sheets were completely adjusted: Hamburg, McCalls Ferry, Quarryville, and Hilliards, Pa.; Fryeburg, Me.; Seale, Ala.; Hollow Springs, Tenn. The following were partly adjusted: Stoneboro, Pa., 30 per cent; Franklin, Pa., 5 per cent; Mercer, Pa., 45 per cent; Emmitsburg, Md., Hammond, N. Y., and Iuka, Miss., each 50 per cent; Canton, N. Y., 80 per cent; Antwerp, N. Y., 70 per cent; Milledgeville, Ga., 25 per cent.

In the triangulation and computing section the following computations were made:

Level circuits were adjusted in the Georgetown and Seaford (Del.) quadrangles.

Level circuits were adjusted in the Emmitsburg, Hagerstown, and Taneytown (Md.) quadrangles. Latitudes, departures, and geographic positions were computed for the Taneytown quadrangle.

Level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Tallahatchie drainage district (Miss.). Geographic positions were computed in the Burnsville (Miss.) quadrangle.

Level circuits were adjusted in the Antwerp, Bath, Canton, and Hammond (N. Y.) quadrangles, and latitudes, departures, and geographic positions were computed in the Antwerp and Hammond quadrangles.

For the additional control of the Mount Guyot and Knoxville (Tenn.-N. C.) quadrangles, geodetic positions were computed.

Level circuits were adjusted in the Bellefonte, Franklin, Hamburg, Hilliards, and Stoneboro (Pa.) quadrangles. Latitudes, departures, and geographic positions in the Franklin, Hilliards, Stoneboro, and Mercer (Pa.) quadrangles were computed. Geodetic positions in the Berlin, Confluence, Hyndman, and Myersdale (Pa.) quadrangles were computed.

Level circuits were adjusted in the Memphis and Pikeville (Tenn.) quadrangles, and latitudes, departures, and geographic positions were computed in the Pikeville and Hollow Springs (Tenn.) quadrangles.

Level circuits in the Virgilina district (Va.) were adjusted.

Level circuits were adjusted in the Bald Knob, Charleston special, Clay, Clendennin, Dublin, Fayetteville, Gassaway, Gilbert, Hinton, Logan, Madison, Montgomery, Midkiff, Pocahontas, St. Albans, Wayne, Welch, and Peytona (W. Va.) quadrangles. Geodetic positions were computed in the Fayetteville, Logan, Madison, Montgomery, and Peytona quadrangles.

Level lists covering the work done in the entire State of West Virginia were assembled, computations and readjustments being made where necessary, preparatory to issuing a bulletin (Bulletin 399).

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, Oklahoma, and Wisconsin. This work comprised the survey of 24 quadrangles and the revision of 1 quadrangle. In addition, 12 quadrangles and 1 special area were partly surveyed and 1 special area was partly resurveyed. The total new area mapped was 4,957 square miles—370 for publication on the scale of 1:125,000, 4,521 for publication on the scale of 1:62,500, and 66 for publication on the scale of 1:24,000. The area resurveyed was 483 square miles—283 for publication on the scale of 1:62,500 and 200 for publication on the scale of 1:24,000. In connection with this work 1,807 miles of primary levels and 45 miles of precise levels were run and 431 permanent bench marks were established.

Triangulation, primary traverse, and precise leveling were carried on at various times by three parties, the work being distributed over portions of Illinois, Iowa, Kentucky, Minnesota, Missouri, and Ohio. The area covered by primary traverse was approximately 5,000 square miles, and by triangulation approximately 1,000 square miles, furnishing control for 24 15-minute quadrangles, 1,278 miles of primary traverse being run and 132 permanent marks set.

Topographic surveys in central division from July 1, 1908, to June 30, 1909.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.		Primary traverse.	
		1:125,000.	1:62,500.			Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	New.	Resurvey.					
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Arkansas	50	329			329	169	31		
Illinois	5-20		775		775	459	97	432	43
Indiana	20		323		323	52	13		
Iowa	20		174		174	73	22	28	3
Kansas	20				[a] 151	107			
Kentucky	20		302		302	53	9	149	13
Michigan	20		175		[a] 241	68	17		
Minnesota						77	13	166	17
Missouri	20		126	65	[a] 240	161	43	80	8
Ohio	20		2,230		2,230	495	146	423	48
Oklahoma	50	41			41				
Wisconsin	10		416	218	634	138	40		
		370	4,521	283	5,440	1,852	431	1,278	132

[a] 200 square miles of resurvey (151 in Kansas and 49 in Missouri) and 66 square miles in Michigan, all for publication on the scale of 1 : 24,000.

DETAILS OF WORK BY STATES.

Arkansas-Oklahoma.—The survey of the De Queen quadrangle, in Sevier, Howard, and Polk counties, Ark., and McCurtain County, Okla., was commenced by C. G. Anderson, F. W. Hughes, H. H. Hodgeson, and C. L. Sadler. The total area mapped was 370 square miles, 41 being in Oklahoma, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area W. A. Gelbach ran 169 miles of primary levels and established 31 permanent bench marks.

Illinois.—The governor of Illinois allotted $8,000 for the continuation of cooperative topographic surveys in the State and the United States Geological Survey allotted a like sum for the same purpose.

The survey of the Murphysboro quadrangle, in Jackson and Perry counties; the Okawville quadrangle, in Clinton, Washington, and St. Clair counties; the Hardinville quadrangle, in Crawford, Lawrence, and Jasper counties; and the Carlyle quadrangle, in Clinton and Bond counties, was completed; that of the Galena and Apple River quadrangles, in Jo Daviess County; the Baldwin quadrangle, in Randolph County; the Lasalle quadrangle, in Lasalle, Bureau, and Putnam counties, and the Vandalia quadrangle, in Fayette County, was continued; and that of the Bridgeport quadrangle, in Lawrence and Wabash counties; the Hennepin quadrangle, in Putnam, Bureau, and Lasalle counties; the New Athens quadrangle, in St. Clair and Monroe counties; and the Carmi quadrangle, in White, Edwards, Wayne, and Posey counties, was commenced. This work was done by W. J. Lloyd, M. Hackett, E. W. McCrary, Lee Morrison, E. L. Hain, G. L. Gross, J. W. Lowell, S. K. Atkinson, A. L. Hambrecht, A. T. Fowler, J. A. Duck, Frank Tweedy, B. A. Jenkins, J. F. McBeth, and G. R. Hoffman, the total area mapped being 775 square miles, for publication on the scale of 1:62,500, with contour intervals of 20 and 5 feet. For the control of these areas 459 miles of primary levels were run and 97 permanent bench marks were established by W. A. Gelbach. For the control of the Baldwin quadrangle, in St. Clair, Randolph, and Monroe counties; the Shawneetown quadrangle, in Gallatin and Hardin counties; the Waterloo, Sparta, Crystal City, and Renault quadrangles, in Union, Washington, Randolph, and Perry counties; the Lincoln quadrangle, in Logan County; and for the Lasalle, Hennepin, Carmi, and Bridgeport quadrangles mentioned above, J. R. Ellis and C. B. Kendall ran 432 miles of primary traverse and set 43 permanent marks.

Indiana.—The survey of the Bloomington quadrangle, in Monroe, Owen, and Green counties, was completed by C. L. Sadler, who, assisted by L. P. Jerrard, also completed the survey of the Clay City quadrangle, in Clay, Vigo, Owen, and Putnam counties, the total area mapped being 323 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Clay City quadrangle 52 miles of primary levels were run and 13 permanent bench marks were established by Mr. Jerrard.

Iowa.—The state geologist allotted $1,750 for cooperative topographic surveys in Iowa and the Federal Survey allotted a like sum for the same purpose. The survey of the Milo quadrangle, in Marion and Warren counties, was completed, and that of the Knoxville and Pella quadrangles, in Marion and Mahaska counties, was commenced by A. T. Fowler, J. G. Staack, and M. Hackett, the total area mapped being 174 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas 73 miles of primary levels were run and 22 permanent bench marks were established by G. E. Heebink, and 28 miles of primary traverse were run and three permanent marks were set by J. R. Ellis.

Kentucky.—For the continuation of the cooperative topographic survey of the State, the state geologist allotted $3,000 and the Federal Survey allotted a like sum. The survey of the Princeton quadrangle, in Caldwell, Lyons, and Hopkins counties, was completed, and that of the Riverview quadrangle, in Jefferson and Bullitt counties, was commenced. This work was done by A. O. Burkland, C. D. S. Clarkson, and R. E. Johnson, the total area mapped being 302 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Princeton quadrangle 53 miles of primary levels were run and 9 permanent bench marks were established by E. C. Bibbee. Primary triangulation was extended through Lewis and Rowan counties by E. L. McNair, and furnished partial control for the Vanceburg, Olive Hill, Soldier, Quincy, and Morehead quadrangles, 8 stations being occupied and 9 permanent marks set. Primary triangulation for the Kentucky portion of the Williamson quadrangle, in Pike and Martin counties, was completed, and that for the east half of the old Prestonburg quadrangle, in Floyd, Johnson, and Lawrence counties, was begun by E. L. McNair and R. C. Seitz, 3 permanent marks being set. For the control of the Shawneetown quadrangle, in Union and Crittenden counties, J. R. Ellis ran 11 miles of primary traverse and set 1 permanent mark. For the control of the Horsebranch, Rochester, and Morgantown quadrangles, in Ohio, Grayson, Butler, Warren, and Logan counties, C. B. Kendall ran 138 miles of primary traverse and set 12 permanent marks.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the state geologist and the United States Geological Survey each allotted $1,000. The survey of the Fowlerville quadrangle, in Ingham and Livingston counties, was completed, and that of the Mason quadrangle, in Ingham County, was commenced. This work was done by C. D. S. Clarkson and A. M. Walker, the total area mapped being 175 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition to the cooperative work, the survey of the Calumet special quadrangle, in Houghton County, was commenced by A. M. Walker, who mapped 66 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet. For the control of this area 68 miles of primary levels were run and 17 permanent bench marks were established by F. H. West. Revision of culture on an irregular area included in the Crystal Falls, Iron River, and Ishpeming quadrangles and adjoining areas was accomplished by A. T. Fowler.

Minnesota-Wisconsin.—For the control of the Center City, Stillwater, and Afton quadrangles, in Washington, Chisago, Ramsey, and

Dakota counties, Minn., and Polk, St. Croix, and Pierce counties, Wis., J. R. Ellis ran 166 miles of primary traverse and established 17 permanent marks.

Missouri.—For the continuation of cooperative topographic surveys in Missouri the state geologist and the United States Geological Survey each allotted $5,000. The resurvey of the Ste. Genevieve quadrangle was continued, and resulted in the completion of the Higdon quadrangle, in Ste. Genevieve, Perry, Madison, St. Francois, and Bollinger counties. This work was done by C. G. Anderson and F. W. Hughes, who also partly completed the survey of the Rolla quadrangle, in Phelps and Dent counties. The new area mapped was 126 square miles and that resurveyed was 65 square miles, all being for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Rolla and Sullivan quadrangles 45 miles of precise levels were run by E. L. McNair and 43 miles of primary levels by C. H. Swift, in connection with which 23 permanent bench marks were established, and 80 miles of primary traverse were run and 8 permanent marks set by J. R. Ellis. Leigh D. Townsend ran 37 miles of primary levels and set 10 permanent bench marks for the control of the Kennett quadrangle, in Dunklin County.

Kansas-Missouri.—The resurvey of an area comprising the Fort Leavenworth special quadrangle, in Jefferson, Atchison, and Leavenworth counties, Kans., and Platte County, Mo., was continued by J. G. Staack, the total area mapped being 200 square miles, of which 49 are in Missouri, for publication on the scale of 1:24,000, with a contour interval of 20 feet. For the control of this area G. E. Heebink ran 143 miles of primary levels, of which 36 miles, with the 10 permanent bench marks established, were in Missouri.

Ohio.—The governor of Ohio allotted $10,000 for the continuation of the cooperative topographic survey of the State and a like sum was set apart for the same purpose by the United States Geological Survey. The survey of the Frazeysburg, Conesville, Zanesville, Philo, New Lexington, McConnellsville, and Granville quadrangles, in Knox, Licking, Muskingum, Coshocton, Morgan, Perry, Hocking, and Athens counties; the Cambridge quadrangle, in Guernsey, Coshocton, and Tuscarawas counties; and the Eaton quadrangle, in Preble and Butler counties, was completed. That of the Caldwell, Cumberland, and Antrim quadrangles, in Morgan, Washington, Noble, Coshocton, Muskingum, Harrison, and Tuscarawas counties; and the Delphos quadrangle, in Van Wert and Allen counties, was partly completed; and that of the Navarre, Canal Dover, Carrollton, Coshocton, New Comerstown, and Uhrichsville quadrangles, in Wayne, Stark, Holmes, Coshocton, Tuscarawas, Carroll, Columbiana, and Harrison counties; and the Laurelville quadrangle, in Hocking and Vinton counties, was commenced. This work was done by J. H. Jennings, J. H. Renshawe, Chas. Hartmann, jr., A. O. Burkland, Fred Graff, jr., O. H. Nelson, H. H. Hodgeson, C. W. Goodlove, J. A. Duck, L. R. Ebert, and C. D. S. Clarkson, the total area mapped being 2,230 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet For the control of these quadrangles 495 miles of primary levels were run and 146 permanent bench marks were set by C. E. Bibbee, S. K. Archer, and H. B. Hoel. For the control of the Eaton quadrangle 23 miles of primary traverse were run and 4 permanent marks were set by J. R. Ellis. For the control of the Berne, Celina, Decatur, Delphos, Loramie, Covington, Troy, Spencerville, and Van Wert quadrangles, in Mercer, Van Wert, Putnam, Allen, Paulding, and Auglaize counties, J. R. Ellis ran 400 miles of primary traverse and set 44 permanent marks.

Wisconsin.—The survey of the Fond du Lac and Neenah quadrangles, in Fond du Lac, Winnebago, and Calumet counties, was completed by H. L. McDonald and W. C. Penn, the total area mapped being 416 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of these areas 93 miles of primary levels were run and 25 permanent bench marks were set by Edward Bandli. The revision of the Waterloo quadrangle, consisting of 218 square miles in Dodge and Jefferson counties, was completed by A. T. Fowler, E. L. Hain, and W. C. Penn. For the control of this quadrangle 45 miles of primary levels were run and 15 permanent bench marks were set by Edward Bandli.

DRAINAGE SURVEYS IN MINNESOTA.

A further appropriation of $10,000 was made by Congress under the Indian act for the completion of the survey of the swamp areas in the ceded lands of the Chippewas in Roseau, Beltrami, Marshall, Red Lake, and Koochiching counties, the work being assigned by the Secretary of the Interior to the United States Geological Survey. The work was completed by A. P. Meade, approximately 1,700 square miles being covered by a network of levels; 77 miles of primary levels were also run, in connection with which 13 permanent bench marks were established. The maps have been completed and transmitted with the final report to the Secretary of the Interior to be submitted to Congress.

OFFICE WORK.

The drafting of the following sheets was completed: Milo, Iowa; Herrin, Murphysboro, Hardinville, Carlyle, and Okawville, Ill.; Granville, Zanesville, Philo, Conesville, Frazeysburg, McConnellsville, and New Lexington, Ohio; Bloomington and Saline City, Ind.; Princeton, Ky.; Milford and Fowlerville, Mich.; Higdon and Macon, Mo.; Waterloo, Fond du Lac, and Neenah, Wis.; Leavenworth, Kans.; map of the ceded Chippewa lands of the Red Lake Indian Reservation, Minn.

Progress in the drafting of additional sheets was made as follows: Knoxville, Iowa, 50 per cent; De Queen, Ark., 5 per cent; Fort Leavenworth special, Kans.-Mo., 80 per cent; Calumet special, Mich., 30 per cent; Rolla, Mo., 55 per cent; Antrim, Cumberland, and Eaton, Ohio, 15 per cent.

The following sheets were adjusted: Galena, Apple River, La Salle, Hennepin, and New Athens, Ill.; Caldwell, Summerfield, Uhrichsville, Carrollton, and Laurelville, Ohio; Riverview, Ky.-Ind., 80 per cent; Mason, Mich.

In the triangulation and computing section the following computations were made:

Level circuits were adjusted in the De Queen (Ark.) quadrangle.

Level circuits were adjusted in the Kennett quadrangle (Ark.-Mo.).

Level circuits were adjusted in the Apple River, Beardstown, Bridgeport, Carmi, Clinton, Dawson, Decatur, Hennepin, Kenney, La Salle, Lincoln, Mason City, Mount Carmel, Niantic, Petersburg, and Saidora (Ill.) quadrangles. Latitudes, departures, and geographic positions were computed in the Baldwin, Bridgeport, Carmi, Hennepin, La Salle, and Shawneetown (Ill.) quadrangles. Level lists covering the work done in the entire State of Illinois were assembled, computations and readjustments being made where necessary, preparatory to issuing a bulletin (Bulletin 421).

Level circuits were adjusted in the Clay City (Ind.) quadrangle.

Levil circuits were adjusted in the Knoxville (Iowa) quadrangle and latitudes, departures, and geographic positions were computed in the Knoxville and Pella (Iowa) quadrangles.

Level circuits were adjusted in the Marion, Princeton, and Providence (Ky.) quadrangles. Geographic positions were computed in the Shawneetown, Soldier, and Vanceburg (Ky.) quadrangles. The reduction of azimuth observations in the Horsebranch, Morgantown, and Rochester (Ky.) quadrangles was accomplished.

Level circuits were adjusted in the Calumet special, Fowlerville, and Mason (Mich.) quadrangles. Latitudes, departures, and geographic positions were computed in the Fowlerville and Mason quadrangles.

Latitudes, departures, and geographic positions were computed in the Afton, Center City, and Stillwater (Minn.) quadrangles.

Level circuits were adjusted in the Hayti, Higdon, Knobview, New Madrid, Rolla, St. James, and Weingarten (Mo.) quadrangles. Geographic positions were computed on the Rolla quadrangle. The office computation was made of the precise-level line extending over the De Soto, Rolla, St. James, and Sullivan (Mo.) quadrangles.

Level circuits were adjusted in the Antrim, Caldwell, Cambridge, Conesville, Coshocton, Cumberland, Eaton, McConnellsville, New Comerstown, Philo, Summerfield, and Zanesville (Ohio) quadrangles. Latitudes, departures, and geographic positions were computed in the Berne, Covington, Delphos, Eaton, Loramie, Sidney, Spencerville, and Van Wert (Ohio) quadrangles. Level lists covering the work done in the entire State of Ohio were assembled, computations and readjustments of level circuits being made where necessary, preparatory to issuing a bulletin (Bulletin 411).

Level circuits were adjusted in the Fond du Lac, Neenah, and Waterloo (Wis.) quadrangles.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Colorado, Montana, New Mexico, North Dakota, Oklahoma, Texas, and Wyoming. This work comprised the survey of five quadrangles and four special areas and the revision of six quadrangles. In addition, eight quadrangles and two national forests were partly surveyed and one quadrangle was partly revised. The total new area mapped was 3,691 square miles—134 for publication on the scale of 1:250,000, 3,268 for publication on the scale of 1:125,000, 239 for publication on the scale of 1:62,500, and 50 for publication on the scale of 1:24,000. The area resurveyed was 6,114 square miles—6,091 for publication on the scale of 1:125,000, 18 for publication on the scale of 1:12,000, 2 for publication on the scale of 1:6,000, and 3 on the field scale of 400 feet to 1 inch. In connection with this work 632 miles of primary levels and 344 miles of precise levels were run and 281 permanent bench marks were established.

Triangulation and precise leveling were carried on by four parties. This work was distributed over portions of Colorado, Montana, New Mexico, and Wyoming, covering an area of about 4,600 square miles and furnishing control for five 30-minute quadrangles and two special areas.

Topographic surveys in Rocky Mountain division from July 1, 1908, to June 30, 1909.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.	
		1:125,000.		1:62,500.		Distance run.	Bench marks.
		New.	Resurvey.	New.			
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*	
Colorado	20-50-100	1,584	....	....	[a] 1,634	591	195
Montana	20-100	406	....	....	[b] 409	....	....
New Mexico	10-100-200	150	....	....	[c] [e] 202	32	12
North Dakota	50	56	....	....	56	....	....
Oklahoma	10-20-50	957	3,193	16	[d] 4,168	229	44
Texas	25-50	....	2,049	....	2,049	....	....
Wyoming	50-100-200	115	849	223	[e] 1,287	124	20
		3,268	6,091	239	9,805	976	271

[a] 50 square miles in Colorado for publication on scale of 1:24,000.
[b] 3 square miles resurvey in Montana on field scale of 400 feet to 1 inch.
[c] 18 square miles resurvey in New Mexico for publication on scale of 1:12,000.
[d] 2 square miles resurvey in Oklahoma for publication on scale of 1:6,000.
[e] 134 square miles (34 in New Mexico, 100 in Wyoming) for publication on scale of 1:250,000.

DETAILS OF WORK BY STATES.

Colorado.—The survey of the Eaton quadrangle, in Larimer and Weld counties, was completed by Frank Tweedy, Gilbert Young, H. S. Starr, and G. W. Lucas, the area mapped being 856 square miles, for publication on the scale of 1:125,000, with a contour interval of 20 feet. The survey of the Breckenridge special quadrangle, consisting of 50 square miles in Summit County, was completed by C. E. Cooke and D. F. C. Moor, for publication on the scale of 1:24,000, with a contour interval of 50 feet. Primary triangulation for this area was done by Mr. Moor, who established 3 stations and set 2 permanent marks. The survey of the Uncompahgre Peak quadrangle, including a small portion of the Cochetopa, Gunnison, and Uncompahgre national forests, in Gunnison and Hinsdale counties, was completed by Gilbert Young and S. T. Penick, the area mapped being 703 square miles, as the Lake City 15-minute quadrangle, which had been previously mapped, was included within it. Primary triangulation for this area was done by Mr. Moor, who occupied 2 stations and set 2 permanent marks. The survey of the Montrose quadrangle, in Montrose, Gunnison, San Miguel, and Ouray counties, was commenced by Mr. Young, no area being mapped. The survey of the Mount Jackson quadrangle, in the Holy Cross National Forest, in Pitkin, Eagle, and Gunnison counties, was continued by S. T. Penick and E. R. Bartlett, the area mapped being 25 square miles. The Uncompahgre Peak and Mount Jackson quadrangles were mapped for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of all the areas surveyed in Colorado, 247 miles of primary and 23 miles of precise levels were run by C. H. Semper, F. J. McMaugh, W. R. Winstead, and R. P. Thompson, 75 permanent bench marks being established. A line of precise levels 321 miles in length, commencing near Denver and extending through Douglas, Denver, Park, Summit, Lake, Eagle, Mesa, and Garfield counties, was run by Mr. Semper, in connection with which 120 permanent bench marks were established.

Montana.—The survey of the Missoula quadrangle, in the Lolo National Forest, in Missoula, Flathead, and Ravalli counties, was continued by Arthur Stiles, William J. Forster, W. M. Kent, and Lee Morrison, the area mapped being 294 square miles. Primary triangulation for this area was done by Mr. Stiles, who occupied 4 stations and set 6 permanent marks. The survey of the Pacific Junction and Avery quadrangles, in Chouteau County, was begun by W. L. Miller, Basil Duke, and G. W. Lucas, the area mapped being 19 square miles. The survey of the Cutbank quadrangle, in Teton County, was commenced by R. W. Berry and H. G. Parry, 93 square miles being completed. All the above work in Montana was for publication on the scale of 1:125,000, with contour intervals of 20 and 100 feet. The survey of a special area in the vicinity of Fort Missoula was made by E. C. Barnard and Arthur Stiles, the area mapped being 3 square miles on the field scale of 400 feet to 1 inch, with a contour interval of 5 feet.

New Mexico.—The survey of the Fort Bayard special area, in Grant County, was completed by C. E. Cooke and S. T. Penick, the area mapped being 18 square miles, for publication on the scale of 1:12,000, with a contour interval of 10 feet. For the control of this area Mr. Cooke located six secondary triangulation stations. The survey of the Graham quadrangle, in Grant and Socorro counties, was commenced by A. B. Searle, A. P. Meade, and R. S. Van Atta, the total area mapped being 150 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Alamo National Forest, in Otero and Lincoln counties, was begun by Van. H. Manning and J. H. Wilke, the area mapped being 34 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. Primary triangulation for this area was commenced by R. B. Robertson, who set 6 permanent marks. K. W. Trimble also ran 32 miles of primary levels and established 12 permanent bench marks.

North Dakota.—The survey of the Nesson quadrangle, in Williams and Stark counties, was begun by Glenn S. Smith, Chester Irvine, Conrad Ecklund, and J. H. Van Wagenen, the area mapped being 56 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

Oklahoma.—The survey of the Pawhuska quadrangle, in Osage County, was completed by H. G. Parry, D. F. C. Moor, Lee Morrison,

H. S. Starr, J. E. Tichenor, D. B. Penick, William J. Forster, and J. S. Rohrer, the area mapped being 957 square miles, for publication on a scale of 1:125,000, with a contour interval of 50 feet. For the control of this area 220 miles of primary levels were run and 39 permanent bench marks were established by H. G. Parry. The survey of the McComb quadrangle, in Cleveland County, was completed by Lee Morrison, the area mapped being 16 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Platt National Park, in Murray County, was completed by B. A. Jenkins, the area mapped being 2 square miles, for publication on the scale of 1:6,000, with a contour interval of 10 feet. For the control of this park Mr. Jenkins ran 9 miles of primary levels and established 5 permanent bench marks. The revision of the culture on the McAlester, Tuskahoma, and Winding Stair quadrangles, in Pittsburg, Latimer, and Le Flore counties, was completed, and that on the Sallisaw quadrangle, in Le Flore County, was partly completed. The total area revised was 3,193 square miles, to be republished on the scale of 1:125,000, with a contour interval of 50 feet.

Texas.—The revision of the culture in the Llano quadrangle, in Llano County, and in the Burnet quadrangle, in Burnet County, was completed by D. B. Penick and C. P. Jamerson, the area covered being 2,049 square miles, for republication on the scale of 1:125,000, with a contour interval of 25 and 50 feet.

Wyoming.—The survey of the Rock Springs quadrangle, in Sweetwater County, was completed by Glenn S. Smith, Lee Morrison, and H. S. Starr, the total area mapped being 223 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Primary triangulation for this area was secured by R. B. Robertson, who occupied 7 new stations, intersected 12 stations, and set 11 permanent marks. J. D. Weems also ran 84 miles of primary levels and established 20 permanent bench marks. The survey of the Sheridan quadrangle, in Sheridan County, was commenced by Charles E. Cooke, assisted by P. W. McMillen and F. H. West, the total area mapped being 115 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area F. H. West ran 14 miles of primary levels and established three permanent bench marks. The survey of an irregular area in the Shoshone National Forest, in Bighorn County, was commenced by E. I. Ireland, the area mapped being 100 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. For the control of this area Otto Meredith ran 26 miles of primary levels and established 7 permanent bench marks. R. B. Robertson extended primary triangulation for the purpose of locating a point on the one hundred and sixth meridian, this being the boundary line between

Crook and Sheridan counties, 12 stations being occupied and 1 point located by intersection. The revision of the culture in the Gallatin quadrangle, in Bighorn County, was completed by Frank Tweedy, the area covered being 849 square miles, to be republished on the scale of 1:125,000, with a contour interval of 100 feet.

OFFICE WORK.

The drafting of the following sheets was completed: Breckenridge special, Eaton, and Uncompahgre Peak, Colo.; New Boston, Linden, Atlanta, and San Marcos, Tex.; Rock Springs, Wyo.; McComb, Pawhuska, and Platt National Park, Okla.; Fort Bayard special, N. Mex.; Fort Missoula special, Mont.; revision of the Tuskahoma, McAlester, and Winding Stair, Okla.; Burnet and Llano, Tex.; Gallatin, Wyo. Progress to the extent of 25 per cent was made in the drafting of the Missoula, Mont., sheet.

In the triangulation and computing section the following computations were made:

The readjustment of primary-level circuits in the Engineer Mountain, Needle Mountains, San Cristobal, and Silverton (Colo.) quadrangles was accomplished. Level circuits in the Uncompahgre Peak, Eaton, and Montrose (Colo.) quadrangles were adjusted and geodetic positions in the Uncompahgre Peak quadrangle were computed. Computations were made for the determination of the elevation of Pikes Peak, in the Pikes Peak special (Colo.) quadrangle. The office computation of the precise-level line extending from Petersburg to Ridgeway (Colo.) was made.

Geodetic positions in the Missoula (Mont.) quadrangle were computed.

Precise-level lists in the Albuquerque, Deming, Eagle, Gallina, Jemes, and Rincon (N. Mex.) quadrangles were revised and prepared.

Level circuits in the Newcomb, Newalla, Pawhuska, and Platt National Park (Okla.) quadrangles were adjusted.

Level circuits in the Bassett, Bogota, Boxelder, and Daingerfield (Tex.) quadrangles were adjusted.

Geodetic positions were computed in the Arvada, Cora, Fremont, Grays River, Grosventre, Hoback, Rock Springs, and Sheridan (Wyo.) quadrangles.

PACIFIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. This work comprised the survey of 8 quadrangles and the resurvey of

11 quadrangles and 2 special areas. In addition, 9 quadrangles and 3 special areas were partly surveyed, and 5 quadrangles were partly resurveyed. The total new area mapped was 12,148 square miles—8,179 for publication on the scale of 1:250,000, 3,198 for publication on the scale of 1:125,000, 577 for publication on the scale of 1:62,500, and 194 for publication on the scale of 1:31,680. The area resurveyed was 1,384 square miles—396 for publication on the scale of 1:125,000, 202 for publication on the scale of 1:62,500, 779 for publication on the scale of 1:31,680, and 7 for publication on the scale of 1:24,000. In connection with this work 2,384 miles of primary levels and 23 miles of precise levels were run and 558 permanent bench marks were established.

Primary triangulation, primary traverse, and precise leveling were carried on at various times by five parties, the work being distributed over portions of Califonia, Oregon, Utah, and Washington. The total area covered by this primary control was about 5,700 square miles, of which 1,400 were controlled by primary traverse, 285 miles being run and 36 permanent marks set.

Topographic surveys in Pacific division from July 1, 1908, to June 30, 1909.

State.	Contour interval.	For publication on scale of—				Total area surveyed.	Levels.		Primary traverse.	
		1:125,000.		1:62,500.			Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	Resurvey.	New.	Resurvey.					
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Arizona....	50–100	471	396	....	....	867	......	......	......	......
California..	5–25 50–100	2,050	....	122	....	a 3,131	1,242	298	120	18
Idaho......	50–100	581	....	61	....	642	96	23	......	......
Nevada....	20–100	....	....	....	....	b c 4,489	319	68	......	......
Oregon....	5–10–50	....	....	327	....	a 341	333	84	......	......
Utah......	100	45	....	....	....	b 3,732	248	41	......	......
Washington	25–50–100	51	....	67	202	b 330	169	44	165	18
	....	3,198	396	577	202	13,532	2.407	558	285	36

a 973 square miles (779 resurvey and 180 new area in California, 14 new area in Oregon) for publication on the scale of 1:31,680.

b 8,179 square miles (4,482 in Nevada, 3,687 in Utah, 10 in Washington) for publication on the scale of 1:250,000.

c 7 square miles resurvey in Nevada for publication on scale of 1:24,000.

DETAILS OF WORK BY STATES.

Arizona.—The resurvey of the area covered by the San Francisco Mountains reconnaissance map was continued by T. Foster Slaughter, M. T. Noyes, and J. W. Muller, and resulted in the completion of the work in the Flagstaff quadrangle, in Coconino County, the area mapped being 396 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

Arizona-California.—The survey of the Parker quadrangle, in Yuma County, Ariz., and San Bernardino and Riverside counties, Cal., was completed by W. C. Guerin, E. C. Guerin, and J. W. Muller, the area mapped being 635 square miles, 164 of which are in California, for publication on the scale of 1: 125,000, with a contour interval of 50 feet.

California.—The Department of Engineering of California allotted $12,000 for the continuation of the cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum for the same purpose. In the Sacramento Valley the resurvey of portions of the Sacramento, Marysville, and Smartsville quadrangles resulted in the completion of the mapping of the Arcade, Antelope, Brighton, Mills, Sheridan, Lincoln, Roseville, Pleasant Grove, New Hope, and Wheatland quadrangles, and in the partial completion of the work in the Folsom, Deer Creek, Scott Ranch, Spencerville, and Yuba City quadrangles. The survey of the Marcuse, Nicolaus, Knights Landing, and Vernon quadrangles, comprising new area, was also completed. The total new area mapped was 180 square miles, in Sutter and Yuba counties, and that resurveyed was 737 square miles, in Placer, Sacramento, Sutter, Yuba, and San Joaquin counties, all being for publication on the scale of 1: 31,680, with a contour interval of 5 feet. This work was done by W. H. Griffin, W. R. McKean, J. H. Sinclair, M. A. Knock, B. Knock, E. C. Williams, E. R. Bartlett, T. H. Moncure, E. L. Sellon, John L. Lewis, A. J. Ogle, and W. B. Kern. On account of the interest of the federal geologists in the Salinas, Mariposa, and Mount Goddard quadrangles, additional cooperation for their partial survey was entered into, the amount appropriated being $6,000 each by the Department of Engineering and the United States Geological Survey. The survey of the Salinas quadrangle, in Santa Clara, San Benito, Monterey, and Santa Cruz counties, was commenced by B. A. Jenkins, E. R. Bartlett, T. H. Moncure, W. H. Griffin, and M. A. Knock, 122 square miles being completed, for publication on the scale of 1: 62,500, with a contour interval of 25 feet. The survey of the Mount Goddard quadrangle, in the Sierra National Forest, in Fresno and Inyo counties, was continued by George R. Davis, assisted by Edward Hyatt, jr., the area mapped being 485 square miles, for publication on the scale of 1: 125,000, with a contour interval of 100 feet. The survey of the Orestimba-Panoche-Cantua special area, in Merced, Stanislaus, Fresno, and Monterey counties, was commenced by George R. Davis, T. H. Moncure, J. H. Sinclair, R. M. La Follette, and J. E. Blackburn, the total area mapped being 1,299 square miles, for publication on the scale of 1: 125,000, with a contour interval of 100 feet. For the control of the cooperative areas and for the Mariposa quadrangle 1,206 miles of primary levels and 23 miles of precise levels were run and

294 permanent bench marks were established by B. A. Jenkins, W. H. Monohan, W. H. Barringer, and L. F. Biggs; 120 miles of primary traverse were run and 18 permanent marks were set by M. A. Knock. Primary triangulation for the control of the Sacramento Valley areas, the Salinas and Mariposa quadrangles, and the Orestimba-Panoche-Cantua special area was done by C. F. Urquhart, 56 stations being occupied and 31 permanent marks set. In addition to the cooperative work in California, the survey of the Smartsville special area, in Yuma and Nevada counties, was completed by J. P. Harrison, W. R. McKean, and C. F. Eberly, the area resurveyed being 42 square miles, on the field scale of 1:31,680, with contour intervals of 5 and 25 feet. The survey of the Mariposa quadrangle, which lies partly in the Sierra National Forest, in Mariposa and Madera counties, was commenced by C. H. Birdseye, assisted by T. P. Pendleton, the area mapped being 102 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Big Bar quadrangle, in the Trinity National Forest, in Trinity County, was continued by J. P. Harrison, no area being mapped. Leveling for the Bridgeport quadrangle, in Mono County, was commenced by C. M. Weston, who ran 13 miles and established 4 permanent bench marks.

Idaho.—The survey of the Meadows quadrangle, in the Weiser National Forest, in Boise and Washington counties, was continued by J. E. Blackburn, A. O. Burkland, and E. A. Lincoln, the total area mapped being 466 square miles. The survey of the Montpelier quadrangle, in the Bear River and Caribou national forests, in Bear Lake County, was commenced by A. E. Murlin and M. A. Knock, the area mapped being 104 square miles. For the control of this area L. F. Biggs ran 96 miles of primary levels and established 23 permanent bench marks. The survey of the Cataldo quadrangle, in the Cœur d'Alene National Forest, in Shoshone, Bonner, and Kootenai counties, was continued by W. O. Tufts, J. W. Muller, and O. G. Taylor, the area mapped being 11 square miles. All the work in Idaho was for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet.

Nevada.—The survey of the Carson Sink quadrangle, in Churchill, Lyon, Nye, and Esmeralda counties, was completed by W. M. Beaman, J. P. Harrison, J. E. Blackburn, and Fred McLaughlin, the total area mapped being 3,687 square miles. The survey of the Hawthorne quadrangle, in Esmeralda County, was commenced by C. G. Anderson, who surveyed 795 square miles. The mapping of both of these quadrangles was done for publication on the scale of 1:250,000, with a contour interval of 100 feet. For their control T. A. Green ran 284 miles and C. M. Weston 35 miles of primary levels, in connection with which 68 permanent bench marks were set. The revision of the Goldfield special area, consisting of 7 square miles in Esmeralda and Nye counties, was completed by W. M. Beaman, for publication on the scale of 1:24,000, with a contour interval of 20 feet.

Oregon.—The state engineer allotted $2,500 for the continuation of cooperative topographic surveys in Oregon, which was met by a like sum from the United States Geological Survey. The Eugene quadrangle, in Lane County, was completed by J. P. Harrison, C. E. Giffin, B. A. Jenkins, and R. M. LaFollette, the area mapped being 213 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. The survey of the Willamette Valley quadrangle, in Benton and Polk counties, was commenced by Robert Muldrow, who mapped 14 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas C. E. Giffin, W. R. Chenowith, and W. B. Kern ran 95 miles of primary levels and established 19 permanent bench marks. Triangulation control was established by Pearson Chapman, who occupied 10 stations and set 6 permanent marks. In addition to the cooperative work, the survey of the Crater Lake quadrangle, in Klamath County, was commenced by Mr. Chapman, the area mapped being 114 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these and adjoining areas 238 miles of primary levels were run from Ashland, through Crater Lake National Park, to Prineville, in connection with which 65 permanent bench marks were set by L. F. Biggs.

Utah.—The survey of the Fish Springs quadrangle, in Millard and Juab counties, was completed by Fred McLaughlin, the area mapped being 3,687 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. For the control of this area T. A. Green ran 248 miles of primary levels and established 41 permanent bench marks. The survey of the Randolph quadrangle, which lies partly in the Bear River National Forest, in Rich and Cache counties, was commenced by Albert Pike, the area mapped being 45 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Primary triangulation for this area was done by C. F. Urquhart, who occupied 8 stations and set 6 permanent marks.

Washington.—The Board of Geological Survey of Washington allotted $10,000 for the purpose of beginning cooperative topographic surveys in the State, which was met by a like sum for the same purpose by the United States Geological Survey. The survey of the Mount Vernon quadrangle, in Skagit and Snohomish counties, was begun by J. R. Eakin and G. V. Brown, the area mapped being 51 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area W. A. Gelbach ran 70 miles of primary levels and set 15 permanent bench marks, and C. A. Clunet ran 165 miles of primary traverse and set 18 permanent marks. The survey of the Quincy and Morrison quadrangles, in Grant County, was begun by C. F. Eberly and H. L. McDonald, the area mapped being 67 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas C. H. Semper ran 99 miles of primary levels and established 29 permanent bench marks. In addition to the cooperative work, the survey of the Mount Baker quadrangle and adjoining areas in the Washington National Forest, in Skagit County, was continued by J. E. Blackburn, the area mapped being 10 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. The revision of the Seattle quadrangle, in King County, was completed by C. F. Eberly and J. G. Hefty, the area covered being 202 square miles, for republication on the scale of 1:62,500, with a contour interval of 25 feet.

IDAHO-WASHINGTON BOUNDARY LINE.

An appropriation of $25,000 was made by Congress for the survey of the Idaho-Washington boundary line, and the work was placed under the charge of the United States Geological Survey by the Secretary of the Interior. The survey was undertaken by S. S. Gannett, C. L. Nelson, and S. G. Lunde, who completed 135 miles of the line, which was marked by 112 iron monuments 6 feet long, 4 inches in diameter, filled with concrete, and by 21 granite monuments 6 feet long and 10 inches square. In addition to these, 174 iron monuments 4 feet long and 3 inches in diameter, filled with concrete, were placed at the closing corners of the public-land surveys. In connection with this work, the topography of an area 1 mile in width along 61 miles of the line was mapped by Mr. Nelson and Bayard Knock, for publication on the scale of 1:62,500. The rest of the boundary line surveyed lies in country already mapped by the United States Geological Survey.

OFFICE WORK.

The drafting of the following sheets was completed: Flagstaff, Ray, and Parker, Ariz.; Eugene, Oreg.; Carson Sink, Nev.; Fish Springs, Utah; Rio Vista, Isleton, Jersey, Bouldin, New Hope, Headreach, Woodbridge, Castile, Galt, Bonceville, Roseville, Pleasant Grove, Lincoln, Sheridan, Vernon, Knights Landing, Nicolaus, Marcuse, Wheatland, and Deer River, Cal.; cultural revision for the Goldfield special, Nev.; Seattle, Wash.; and Smartsville special, Cal.

Progress in the drafting of additional sheets was made as follows: Folsom, Cal., 40 per cent; Meadows, Idaho, 50 per cent.

In the triangulation and computing section the following computations were made.

Level circuits were adjusted in the Benson, Blaisdell, San Simon, Tucson, and Williams (Ariz.) quadrangles. Geodetic positions were computed in the Cochise, Chiricahua, Pearce, and San Simon (Ariz.) quadrangles.

Level circuits were adjusted in the Antioch, Auburn, Cambria, Capitola, Clarksburg, Coalinga, Dunnigan, Etna, Fairoaks, Folsom, Fresno, Grimes, Hatchville, Hollister, Hoopa, Knights Landing, Lincoln, Loma Prieta, Los Banos, Mariposa, Merced, Newman, Panoche, Pejero, Preston, Rio Vista, Salinas, San Martin, San Jose, Santa Cruz, Sawyer Bar, Seiad, Smartsville, Stockton, Wheatland, Woodbridge, Yuba City, and Yreka (Cal.) quadrangles. The computation of triangulation done in the State during 1908 was made in the Sacramento office.

The computation of the field notes of the resurvey of the Washington-Idaho boundary line was made.

Level circuits in the Carson Sink (Nev.) quadrangle were adjusted.

The office computation of the level line extending from Ashland to Prineville (Oreg.) and over the Crater Lake and Jacksonville (Oreg.) quadrangles was made.

Level circuits in the Fish Springs (Utah) quadrangle were adjusted.

Level circuits in the Mount Adams, Mount Baker, Simcoe, and Zillah (Wash.) quadrangles were adjusted. Level lists, including circuits of level lines, in the Moses Lake (Wash.) quadrangle were revised. Computations of latitudes, departures, and geographic positions on the Mount Vernon (Wash.) quadrangle were made.

COMPILATION OF SPECIAL NATIONAL-FOREST MAPS.

The work of preparing the folios of the atlas of the national forests was continued under the direction of A. C. Roberts.

The maps were made on the scale of 1 mile to the inch and published with six townships to the page. All the work of the United States Geological Survey, the General Land Office, and the Hayden, Transcontinental, and Wheeler surveys, as well as that of private surveys, was incorporated in the maps. The status of all lands inside of the forests was obtained in greatest detail from the records of the General Land Office by expert status clerks, and the land classification and the improvements in the forests from the maps of the Forest Service, all these data being shown in colors and symbols on the compiled maps.

Folios were finished during the fiscal year 1908–9 for the following forests: Luquillo, Angeles, Holy Cross, Lolo, Las Animas, Kansas, La Sal, Sitgreaves, Battlement, Coronado, Pocatello, Beartooth, Cheyenne, Teton, Medicine Bow, Absaroka, Sioux, Gunnison, Kaibab, Shoshone, Caribou, Custer, Apache, Sundance, Targhee, Arapaho, Wyoming, Routt, Pecos, and Nebraska, all of which have been lithographed and delivered to the Forest Service.

The following were compiled and are now in the hands of the engraver: Fillmore, Cœur d'Alene, Dixie, Arkansas, Chiricahua (New Mexico portion), San Isabel, Garces, Jefferson, Coconino, Montezuma, Moapa, Minidoka, Bonneville, Tonto, Missoula, Carson, Jemez, Humboldt, White River, Bighorn, Cochetopa, and Uncompahgre.

Folios of the following forests were practically completed: Nezperce, Datil, Modoc, Stanislaus, Powell, Uinta, Cleveland, Tahoe, Pend Oreille, Idaho, Payette, Weiser, Toiyabe, Oregon, Alamo, Prescott, Challis, Kootenai, and Sevier.

The Ashley, Ocala, Caldwell, Inyo, Sierra, Fish Lake, Nebo, and Gila folios were compiled, but the final tracings were not finished; the Ozark, Deerlodge, Beaverhead, Deschutes, Crook, Mono, and Santa Barbara folios were partly compiled; and the San Luis, Sequoia, Umpqua, Cascade, and Cabinet folios were commenced.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

During the season only a small amount of field inspection of topographic mapping was done, as the inspectors were engaged for the greater part of the season in regular topographic field work. J. H. Renshawe, after the completion of his field work in Ohio on the Granville quadrangle, was engaged for the balance of the season in the inspection of work in the Central and Atlantic divisions. After the completion of the revision of the Goldfield special area in Nevada, W. M. Beaman did a small amount of inspection in California. F. E. Matthes devoted his whole time in the field to the demonstration of methods and style of topographic mapping applicable to the country worked in Maine and West Virginia.

During the office season careful attention was given by Messrs. Renshawe and Beaman to the final drawing of topographic sheets, for the purpose of eliminating personal mannerisms and errors of expression, also to the examination of the finished sheets. Mr. Matthes's time was devoted to the inking of his field sheets, to the completion of the report on the Yosemite National Park, and to the revision of the book of instructions for field and office work.

INSTRUMENTS AND TOPOGRAPHIC RECORDS.

During the year all the topographic instruments in the office were examined, and all that were found to be worn out, useless, or of obsolete types were condemned by a committee appointed by the Director. Some of these were deposited in the National Museum, and the remainder were sold at auction. All minor repairs to instruments were made in the Survey shop, the extensive repairs and remodeling being done by outside contractors, as heretofore. In December, 1908, Survey instruments to the value of about $15,000 were destroyed by fire, but all of them were replaced by authorization of Congress, which made a special appropriation therefor.

Thirty-one hundred items were added to the files of topographic records during the year. The triangulation and level plats of all States, the card catalogue of triangulation and primary-traverse stations, and the card catalogue of bench-mark descriptions and elevations were brought up to date.

MAP OF THE UNITED STATES.

Work on the 1:1,000,000 scale map of the United States was begun in July under the direction of A. F. Hassan, and the following progress was made:

The Florida portions of sheets G, H-14, and H-15 were completed; about 90 per cent of the coastal-plain area in North Carolina (sheets I-13, I-14, and J-13) was compiled and about 15 per cent inked and lettered; about 75 per cent of South Carolina (sheet I-14) was compiled; about 95 per cent of the land lines of Illinois (sheets J-15, J-16, K-15, and K-16) were adjusted, about 40 per cent being compiled and 15 per cent inked; about 90 per cent of sheet K-12 (portions of New Hampshire, Massachusetts, Connecticut, and Rhode Island) was compiled and inked; about 30 per cent of sheet K-13 (parts of New York, Vermont, Massachusetts, Connecticut, Pennsylvania, and New Jersey) was compiled; a special sheet of Wisconsin (K-15), latitude 42° 00′ to 44° 00′, longitude 87° 30′ to 90° 00′, was completely compiled and inked, and about 70 per cent of the lettering finished.

WATER-RESOURCES BRANCH.

The work of the water-resources branch during the year has consisted of investigations of (*a*) surface water, (*b*) underground water, (*c*) the quality of water, and (*d*) the effect of mining débris.

SURFACE-WATER INVESTIGATIONS.

The principal work in the investigation of surface waters is the determination of stream flow. For this purpose permanent stations are established on chosen rivers at selected points and the daily discharge is determined by proper engineering means, a description of which is not necessary to this report. Such work, carried on for a series of years, results in a continuous record of the flow of the rivers that covers all extremes of high and low water. So far it has not been possible with the money available to conduct this work in all parts of the country, or indeed in any part, with the thoroughness that is necessary to obtain the results that the importance of the work demands. To do the work as it should be done would require an appropriation at least twenty times that now made, or, in other words, $2,000,000 annually instead of the $100,000 that has been available during each of the last two years and has been appropriated for the next fiscal year.

It is not necessary, however, to expend such an amount in order to procure results of enormous value. If $200,000 were appropriated, as in the four years from 1902 to 1906, a very good showing could be made, and, although the work would have to continue for a longer period than if a larger amount were made available, nevertheless in the course of time all the necessary facts could be gathered.

During the last fiscal year the Survey has maintained 347 gaging stations in the United States. The stations are well scattered over the entire country, except in certain low-lying portions. The greatest number per unit of area are located in the high mountains, where critical conditions of run-off exist. In addition to these stations 128 stations have been maintained in cooperation with the Reclamation Service, 82 stations in cooperation with private persons, and 272 stations in cooperation with States. The cooperating States, under special or general legislative authority, have furnished the funds necessary to maintain these stations, which have been established for their own particular purposes. The results obtained are, of course, useful in general and special ways for the purposes of the Geological Survey, and they contribute largely to the sum total of information available.

The following is a list of stations by States:

Gaging stations maintained wholly or in part by United States Geological Survey.

State.	Number of stations maintained during fiscal year 1908-9.				
	By the Survey.	In cooperation with—			Total.
		States.	Reclamation Service.	Private persons.	
Alabama	8			1	9
California	38	24		[a] 18	80
Colorado	6	18	5	21	50
Connecticut	1			1	2
District of Columbia	1				1
Georgia	23				23
Idaho	7	3	12		22
Illinois	2	18			20
Indiana	2				2
Iowa	1	1			2
Maine	4	10		11	25
Maryland	1	7			8
Massachusetts		2		4	6
Michigan	7			9	16
Minnesota	2	33		1	36
Mississippi	2	8			10
Missouri	1				1
Montana	23	20	50		93
Nebraska		7			7
Nevada	5		8		13
New Hampshire				6	6
New Jersey	3				3
New Mexico	13	3	7		23
New York	16	28		3	47
North Carolina	13	12			25
North Dakota	10	8	2		20
Ohio	2	1			3
Oregon	40	40	8		88
South Carolina	4				4
Tennessee	10				10
Utah	24	7	7		38
Virginia	18			2	20
Vermont		9			9
Washington	18	10	26		54
West Virginia	24				24
Wisconsin	4			5	9
Wyoming	14	3	3		20
	347	272	128	82	829

[a] Maintained by the city of Los Angeles.

Other features of the surface-water investigations consist of the survey of rivers to determine their slope and the survey of sites for reservoirs. These surveys, however, have been few in number and are not at the present time regarded as so important as the determination of stream flow.

GROUND-WATER INVESTIGATIONS.

The investigation of the water resources that exist below the surface of the ground equals in importance that of surface waters. The soil and the rocks are our greatest reservoirs. They supply more people with domestic water than all the streams, and in certain sections of the country underground water has been the chief source of the prosperity that they now enjoy. The determination of ground-water supplies is largely a geologic study, for the water that sinks into the ground is governed in its course and occurrence by the character of the rock formations which it encounters and through which it passes.

The total allotment made for ground-water investigations for the fiscal year 1909 was $12,650, of which $4,150 was transferred for expenditure under the chief geologist in the investigation of the geology and ground waters of the Coastal Plain of the Atlantic and Gulf States. The remaining allotment of $8,500 was insufficient to maintain the regular members of the staff and to continue the investigations under way by the special experts from various universities. In order, therefore, that the division might not be disorganized, two supplementary agreements were entered into. By the terms of one of these agreements H. R. Johnson was assigned to the geologic branch for one-half of the fiscal year to assist in the investigation of the oil fields of California, the water-resources branch agreeing to employ him during the remainder of the year. Under the second agreement the State of Utah, through Caleb Tanner, state engineer, agreed to pay the field expenses of O. E. Meinzer while he carried on an investigation in that State, his salary and a few incidental expenses to be borne by the Federal Survey. By virtue of these adjustments it became possible to hold together the force throughout the year and to take up three new problems.

G. A. Waring, who at the close of the fiscal year 1908 had completed his reports on the geology and ground waters of south-central Oregon, was assigned to make a systematic study of the springs of California, especially those that are reputed to have medicinal properties and are the principal attraction of pleasure and health resorts. It is estimated that this work will require two years for completion.

The second new investigation undertaken was that of the occurrence, distribution, and quantity of the underground waters in the Antelope Valley and adjacent parts of the Mohave Desert in Los Angeles and San Bernardino counties. H. R. Johnson was assigned to this field for such portion of his time as was to be given to the water-resources branch. He entered the field early in November and completed the field investigations in January, reaching the Washington office about the middle of February. By a supplementary agreement he was assigned to the geologic branch for an additional two months. At the close of the fiscal year the preparation of Mr. Johnson's report on the field work was well under way, and he expected to complete it by August 1.

The third of the new investigations undertaken was that supported jointly by the United States Geological Survey and the State of Utah. O. E. Meinzer received this assignment, his particular field being Juab, Millard, and Iron counties in southwestern Utah. This work was so distributed as to supplement and coordinate with that done in earlier years by G. B. Richardson and W. T. Lee. Mr. Meinzer's field work closed about the 1st of November, 1908, and soon thereafter he returned to the Washington office, where he was directed to complete the preparation of a report on the ground waters of southern Minnesota begun some years ago by M. L. Fuller and C. W. Hall. He was occupied through practically all of the last half of the fiscal year with this work, and the manuscript of the report was submitted about the middle of June, 1909.

The responsibility for the classification of irrigable and nonirrigable lands, thrown upon the Survey by the passage of the " enlarged homestead act," made advisable the examination of particular areas. On the completion of the Minnesota report Mr. Meinzer was sent to New Mexico to make certain of these examinations and to supplement his work of the summer of 1908 in the Utah field, it having been found that additional information was required before a satisfactory report could be prepared.

Prof. C. H. Gordon, of Knoxville, Tenn., has continued the preparation of two reports on the geology and ground waters of portions of northern Texas. The first of these reports was submitted to the Survey early in the calendar year 1909, and at the close of the fiscal year some progress had been made on the second report.

Prof. W. H. Norton and Prof. W. S. Hendrixson, of Iowa, have made some progress during the year on their report on Iowa's ground waters; but university duties require the greater part of their time and energy, and during the coming fiscal year Mr. Meinzer, who is familiar with the Iowa field, will be assigned thereto for a short time in order that some delayed field work may be done and the report completed.

W. C. Mendenhall, in charge of ground-water investigations, remained in the Washington office until the latter part of August, 1908, completing a preliminary report on the ground waters of the San Joaquin Valley, California, which was submitted for publication about the 1st of September. He then joined Mr. Waring in California, and early in October spent several weeks with Mr. Meinzer in southwestern Utah reviewing his work there. Later Mr. Mendenhall went to Tucson, Ariz., to go over with Professor Smith, of the University of Arizona, a field in the Santa Cruz and Rillito valleys, in which certain experiments had been conducted to determine the amount and availability of the underflow.

In the spring of 1909, at the suggestion of W. H. Code, chief engineer of the Indian Service, an agreement was entered into by the terms of which the Geological Survey has undertaken to investigate the underground-water conditions in the Moki and Navajo reservations. The Office of Indian Affairs has set aside $3,000 for the work, and Prof. H. E. Gregory, of Yale University, has been assigned to the field. He and Mr. Mendenhall spent the month of May with M. R. Campbell, of the geologic branch, and H. F. Robinson, of the Indian Service, superintendent of irrigation for Arizona and New Mexico, visiting the reservations and determining the fields to be specially investigated and the best methods of carrying out the work. Professor Gregory will complete his researches in August or September and will prepare a final report some time thereafter, the agreement being that preliminary reports shall be sent to the Office of Indian Affairs from the field immediately after the completion of each important unit in the problem.

INVESTIGATIONS OF THE QUALITY OF WATER.

The water resources are not determined on the completion of studies concerning the amount of water. A complete inventory, adaptable for use, requires that the quality of the waters also be considered. No investigations of this sort have been made during the past year, except those in cooperation with the State of California. In previous years a large amount of data had been accumulated, and the effort of the past year has been concentrated on the compilation and assembling of these data and the making of proper deductions for reports. These reports relating to the quality of water in various parts of the country and its industrial usefulness are in preparation and will be published at an early date.

DÉBRIS INVESTIGATION.

The investigation of problems connected with the overloading of California rivers by mining débris was continued under the charge of G. K. Gilbert. The work included additional measurements of pits excavated by hydraulic mining and additional studies of the contributions to the detrital load of streams through the cultivation of the soil and the grading and use of wagon roads. In the hydraulic laboratory of the Survey at the University of California further study was made of the laws controlling the transportation of detritus by running water. Experiments with assorted detritus washed through straight channels were supplemented by others with mixed detritus and by a series with crooked channels. The general series of experiments representative of natural stream work, in which the bed of the channel is composed of detritus and its form is determined by the stream itself, was carried to completion, and a second series was begun representative of flumes and other artificial channels in which the form of the channel bed is rigid and unchanging. Incidental to this work was an experimental study of a specially constructed Pitot or Darcy current gage. A report on the overloaded rivers is in hand.

STATE COOPERATION.

It has been the custom during previous years for States which so desired to cooperate with the Geological Survey along certain lines of investigation, for the purpose of procuring the final results at an earlier time than would be possible under the limited allotments that the Survey is obliged to make. Such cooperation has been helpful and has figured largely in the scope of the work. The States, either by special legislative appropriation or from a general fund that may be so expended, make allotments to be used for this work, under the general supervision of the Director of the Federal Survey.

In some States the amounts allotted by each party are equal; in others the Survey pays a larger or smaller part, according to its estimate of the comparative importance of the work or the limit of the Survey's appropriation. The practice is to give due consideration to the demands and needs of the various States for such investigations and to allot the appropriation according to their relative merits. Such allotments having been made, the States determine the amounts that they can afford to contribute. All arrangements are made under formal agreement, and the following is a statement of the extent of such cooperation during the fiscal year 1908–9 and the character of the work performed.

California.—An agreement in continuation of previous ones with this State was entered into on July 1, 1908, providing that during the fiscal year then beginning cooperative investigations of the flow of rivers in the State should be made, together with the survey of reservoir and dam sites for impounding flood water; the survey of main diversion canals and their headworks for the purposes of development of irrigation, navigation, municipal water supply, and water power; the study of underground waters; and the necessary computations and estimates for all these investigations. The Geological Survey contributed $11,500 and the State $8,500. A similar agreement, covering the same investigations for the year beginning July 1, 1909, has been executed, the two parties thereto contributing $9,000 each.

Colorado.—On July 1, 1908, an agreement was entered into whereby the state engineer of Colorado consented to pay the salaries of observers at 16 stations, the remainder of the expense thereof to be paid by the Survey. The total amount expended by the state engineer during the year was about $750. During the same period the Survey expended approximately $5,000.

Idaho.—A cooperative agreement was entered into with the state engineer of Idaho on April 1, 1909, to continue in effect until June 30, 1910, providing for a determination of the flow of the rivers of the State, together with investigations and observations necessary or related thereto, for the purpose of development of irrigation, municipal water supply, and water power. The amounts contributed by the two parties are $2,000 each.

Illinois.—During the past year 16 gaging stations have been maintained in Illinois at the expense of the Illinois Improvement Commission. These stations were maintained for the purpose of determining facts necessary to the establishment of an intelligent drainage system throughout the State, and about $1,800 was expended during the year.

Massachusetts.—An agreement to take effect July 1, 1909, with the governor of Massachusetts, under the authority of a law passed by the Commonwealth for that purpose, provided for the determination of the flow of rivers in the State and allied investigations relative to water powers, each party contributing the sum of $1,050.

New York.—Two agreements have been in force in this State. The first is with the state engineer, to whom the legislature grants an annual appropriation of $1,500 for stream-flow measurement work. This is met by a like amount allotted by the Geological Survey. The state appropriation is used to maintain purely intrastate investigations; the allotment of the Survey is expended on interstate streams. The second feature of cooperation involved an agreement with the New York State Water Supply Commission, which allotted from its general appropriation the sum of $2,700 for the maintenance of 11 stations on rivers that were being studied by it.

Maine.—An agreement with the State of Maine involved the expenditure of $2,500 by the Geological Survey and $3,500 by the State, the money being used for the maintenance of gaging stations and the survey of rivers to determine their profiles, for water-power purposes. Sixteen gaging stations were maintained and a survey of the East Branch of Penobscot River was made.

North Carolina.—Under an agreement with the state geologist, the salaries of observers at 12 stations in North Carolina were paid out of state funds.

Maryland.—Under an agreement with the state geologist, the salaries of observers at seven stations in Maryland were paid from state funds.

Minnesota.—An agreement to take effect May 15, 1909, provided for the determination of the flow of rivers, the survey of rivers and reservoir sites, and allied investigations necessary to the determination of the water resources of the State, which was represented by the State Drainage Commission and contributed $12,500, against $2,750 allotted by the Geological Survey; and further provided that on June 30, 1910, a new agreement shall be made, under which the Geological Survey shall contribute to the work as large a sum as is possible under an equitable distribution of the federal appropriation, due regard being given to the appropriations made by Congress for such work, it being understood that said Survey shall during subsequent years make the allotments necessary to complete the work, which shall eventually equal in the aggregate the contributions made by the State of Minnesota, all being contingent on the action of the Congress of the United States in continuing this feature of the Survey's work.

Nebraska.—An agreement, entered into on July 1, 1908, provided for the maintenance of 30 gaging stations throughout the State, each party contributing the sum of $650.

Oregon.—The agreement with the State of Oregon during the past year was in continuation of similar agreements maintained during several years previous, providing for an expenditure by each party of $2,500 for the determination of the flow of the rivers of the State and investigations and observations necessary for purposes of irrigation, municipal water supply, and water power.

Utah.—An agreement made with the state engineer of Utah, under authority of a special act of the legislature, was entered into on April 1, 1909, and will continue until June 30, 1910. It provides for an expenditure by each party of $2,000 and contemplates the measurement of stream flow and the study of irrigation, municipal water supply, and water-power problems. A similar agreement, informal in character, was made to cover ground-water investigations, and has already been described. (See p. 91.)

Vermont.—Under an act of the legislature of Vermont, the governor was authorized to enter into an agreement with the Director of the Geological Survey for making an investigation and report on the water resources of that State. This agreement was entered into April 1, 1909, and provides for the expenditure of $1,000 by each party.

Washington.—The State of Washington, under authority of the legislature, entered into an agreement with the Director of the Geological Survey on May 1, 1909, for the maintenance of gaging stations and the determination of water powers within the State, each party contributing the sum of $5,000.

PUBLICATIONS.

The following manuscripts are ready for publication or were in preparation at the close of the fiscal year:

SURFACE WATER SUPPLY PAPERS.

No. 234. Conservation of water resources. Reprints from the report of the National Conservation Commission. In press.

Progress Report, 1907–8, in twelve parts: Parts I and III to XI, 78 per cent completed; Part II (No. 242), in press; Part XII, 98 per cent completed.

Hydrography of Penobscot River drainage, 85 per cent completed.

UNDERGROUND-WATER PAPERS.

No. 227. Underground-waters of South Dakota, by N. H. Darton. In press.

No. 232. Underground-water resources of Connecticut, by H. E. Gregory and E. E. Ellis. In press.

No. 233. Underground waters of the Blue Grass region of Kentucky, by G. C. Matson. Submitted.

Underground waters for farm use, by M. L. Fuller. Submitted.

Well-drilling methods, by Isaiah Bowman. Submitted.

Underground-water papers, 1907–8, by M. L. Fuller et al. 85 per cent completed.

Ground waters of north-central Indiana, by S. R. Capps. 95 per cent completed.

Ground waters of eastern Arkansas, by A. F. Crider. Completed and being examined.

Ground waters of Iowa, by Prof. W. H. Norton and Prof. W. S. Hendrixson. 80 per cent completed.

Underground waters of southern Minnesota, by C. W. Hall, O. E. Meinzer, and M. L. Fuller. 90 per cent completed.

Ground waters of southwestern Utah, by O. E. Meinzer. 50 per cent completed.

Geology and water resources of northeastern Texas, by C. H. Gordon. 85 per cent completed.

Ground waters of north-central Texas, by C. H. Gordon. 50 per cent completed.

Geology and underground waters of the coastal plain of Texas, east of Brazos River, by Alexander Deussen. Completed and being examined.

Denudation and erosion in the southern Appalachians, by L. C. Glenn. Returned to author for revision.

Underground waters of southwestern Ohio, by M. L. Fuller. Submitted.

Ground waters of the Mohave Desert, by H. R. Johnson. 60 per cent completed.

California springs, by G. A. Waring. 30 per cent completed.

Geology and water resources of San Luis Valley, Colorado, by C. E. Siebenthal. Returned to author for revision.

PAPERS ON THE QUALITY OF WATER.

No. 236. Surface waters of the United States, Part I, by R. B. Dole. Submitted.

Surface waters of the United States, Part II, by R. B. Dole. 15 per cent completed.

No. 237. The quality of surface waters of California, by Walton Van Winkle. Completed and awaiting revision.

The quality of waters of Kansas, by H. N. Parker. 92 per cent completed.

The quality of waters of Illinois, by W. D. Collins. 90 per cent completed.

The industrial uses of water, by Herman Stabler. 45 per cent completed.

No. 235. The purification of some textile and other factory wastes; a report based on investigations near Providence, R. I., by Herman Stabler and G. H. Pratt. Submitted.

Chemical denudation in the United States, by Bailey Willis, F. W. Clarke, and R. B. Dole, to be published as Professional Paper. 60 per cent completed.

PERSONNEL.

The water-resources branch has continued under the direct administrative charge of M. O. Leighton, chief hydrographer, assisted by J. C. Hoyt, assistant chief hydrographer. W. C. Mendenhall is geologist in charge of ground-water investigations and R. B. Dole is assistant chemist in charge of investigations of quality of water.

The district engineers in charge of field work of stream gagings, river surveys, etc., are H. K. Barrows, New England; C. C. Covert, New York; R. H. Bolster, middle Atlantic States; M. R. Hall, southern Atlantic and eastern Gulf States; A. H. Horton, Ohio Valley and Central States; Robert Follansbee, Minnesota; J. E. Stewart, Montana, North Dakota, and northern Wyoming; W. B. Freeman, southern Wyoming, Colorado, New Mexico, Kansas, and Nebraska; E. C. La Rue, Utah, Idaho, and Nevada; J. C. Stevens, Oregon and Washington; and W. B. Clapp, California. The computation work is under the charge of R. H. Bolster, assistant engineer.

The geologists engaged in the investigation of ground-water resources, under the direction of W. C. Mendenhall, are H. R. Johnson, G. A. Waring, and O. E. Meinzer.

In addition to these regular employees, occasional services have been rendered by Prof. C. W. Hall, University of Minnesota; Prof. W. H. Norton, Cornell College, Mount Vernon, Iowa; Prof. W. S. Hendrixson, Iowa College, Grinnell, Iowa; and Prof. C. H. Gordon, University of Tennessee, Knoxville, Tenn.

The chemists and engineers who have been engaged in investigations of the quality of water, under the direction of R. B. Dole, are H. N. Parker, Herman Stabler (for part of the year), and Walton Van Winkle.

The débris investigation at the hydraulic laboratory at Berkeley, Cal., has continued under the charge of G. K. Gilbert, assisted by E. C. Murphy.

TECHNOLOGIC BRANCH.

ORGANIZATION AND SCOPE.

The technologic branch of the Survey includes three divisions organized under three separate appropriations—(1) the mine-accidents division, which has for its purpose the protection of the lives of miners in the Territories and in the district of Alaska and the conducting of investigations as to the cause of mine explosions with a view to increasing safety in mining; (2) the fuel division, which has for its purpose the investigation of coals, lignites, and other mineral fuels; and (3) the structural-materials division, which has for its purpose the investigation of structural materials belonging to and for the use of the United States.

The general supervision of the work has remained, as during the previous fiscal year, under J. A. Holmes, expert in charge, and H. M. Wilson, chief engineer.

The technical force of this branch during the fiscal year was as follows: In the mine-accidents division, 6 mining engineers, 5 assistant mining engineers, 1 explosives engineer, 1 electrical engineer, 1 chemist, 5 assistant chemists, and 3 consulting mining engineers employed temporarily as needed; in the fuel division, 9 mechanical engineers, 33 assistant and junior engineers, 5 chemists, 23 assistant chemists, 1 physicist, 2 consulting engineers, and 2 consulting chemists; in the structural-materials division, 4 engineers, 19 assistant and junior engineers, 1 ceramic chemist, 1 assistant ceramic chemist, 1 building-stone expert, 1 chemist, 13 assistant chemists, and 3 consulting engineers employed temporarily as needed.

LABORATORIES AND TESTING FACILITIES.

The scope of the work to be done has rendered necessary the enlargement of the facilities for testing and research; and the interrelations existing between the different lines of investigation authorized by Congress, together with the common need for light, power, and heat, rendered advisable, in the interest of both economy and efficiency, the concentration of the researches at some central station. The fact that at Pittsburg, Pa., and not elsewhere, ample buildings and grounds owned by the Government and not otherwise used were available for such concentration, and the further fact that there was no appropriation available to provide new buildings and grounds for this purpose elsewhere, rendered necessary the establishment of the several testing and investigating laboratories at Pittsburg. Accordingly, and with the approval of the Quartermaster-General of the War Department, the new equipment provided for the investigation of mine explosives was installed under the supervision of J. C. Roberts, assistant chief engineer, in and about seven government buildings on the arsenal tract at Pittsburg, and the equipment of the fuels division which had been in use at Norfolk, Va., during the previous fiscal year was transferred to an adjacent building (No. 13) on the same tract. The chemical work on fuels which had been carried on during the previous fiscal year at the University of California, the Ohio State University, the University of Chicago, and the Carnegie Technical Schools in Pittsburg was, at the beginning of the year, transferred to another special building (No. 21) provided for this purpose on the same tract, and the chemical laboratories for the structural-materials investigations and the investigation of mine explosions and the physical laboratory for fuel investigations were established in other portions of the same building. The equipment for the investigations of clays and clay products under the structural-materials division was installed in and about another building (No. 10) on the arsenal tract, and to this was added certain equipment for other structural-materials investigations, including one 600,000-pound, two 200,000-pound, and one 100,000-pound testing machines, and a variety of other equipment. A 10,000,000-

pound testing machine for testing full-size architectural columns and various engineering materials is now in course of erection.

With these grounds and buildings furnished through the courtesy of the War Department and now well equipped for extensive practical work; with the equipment at St. Louis for the structural-materials investigations connected with the Government's engineering construction and building work in the Mississippi Valley and Western States; and with the smaller special laboratories at Atlantic City, N. J., Northampton, Pa., and Washington, the technologic branch is far better prepared than ever before for conducting in a satisfactory manner the investigations of structural materials, fuels, and mine explosives authorized by Congress.

Under the structural-materials division the investigations of concrete, sands, gravels, stone, and other structural materials at St. Louis were continued in the same buildings and grounds until nearly the end of the fiscal year, when they were temporarily discontinued owing to the necessity of removing from Forest Park the buildings which had been occupied during the last three years for these investigations. Early in June a portion of the equipment was temporarily stored in a building provided by the city of St. Louis, and shortly thereafter it was transferred to a government building in St. Louis under the control of the Corps of Engineers and the Mississippi River Commission. It is expected that the investigations will be continued in this building as soon as adequate funds can be provided. The laboratory for investigating the injurious influence of sea water on concrete and the methods of preventing it was early in the fiscal year transferred from Norfolk, Va., to Atlantic City, N. J., where a suitable and well-located building for this purpose has been leased at a nominal price, and the investigations in this new locality are already under way.

The laboratory for testing cement for use in the construction work of the Panama Canal has during the last four months of the fiscal year been located at Northampton, Pa., where the cement is being manufactured and shipped.

PUBLICATIONS.

During the fiscal year 10 bulletins have been issued, 6 bulletins are in press, and 11 additional bulletins are either in different stages of preparation or have been submitted for publication.

MINE-ACCIDENTS DIVISION.

ORGANIZATION.

The mine-accidents division was organized near the close of the preceding fiscal year under an appropriation approved May 22, 1908.

In addition to the investigations mentioned on pages 14–15, during

April and May, 1909, J. W. Paul, mining engineer, and Axel Larsen, explosives engineer, visited the mine explosives stations and mine rescue stations in England, France, Belgium, Germany, and Austria and made a careful study of the equipment and methods used in investigating mine explosions and in training men in rescue work at mine disasters.

The researches of the mine-accidents division include (*a*) investigations of conditions in mines, under G. S. Rice, chief mining engineer; (*b*) investigations of mine lamps and rescue apparatus for use in mine investigations, under J. W. Paul; (*c*) investigations and physical tests to determine the proper explosives for use in gaseous and dusty mines and the best manner of using such explosives in order to insure safety in mining, under Clarence Hall, explosives engineer; (*d*) investigations and analyses of explosives used in coal mining, under W. O. Snelling, explosives chemist; (*e*) investigations of the conditions under which electricity may be safely used in coal mines where dust or explosive gases are present, under the direction of H. H. Clark, electric engineer; (*f*) investigations of the nature, extent, and distribution of explosive mine gases, under R. T. Chamberlin and N. H. Darton. The primary studies under each of these sections are conducted at the mine experiment station in Pittsburg; but these studies are supplemented by examinations made in selected mines in the important coal fields.

The mine-accidents division also conducts the inspection of coal mines in the Territories, which during the fiscal year was limited to New Mexico. This work was under J. E. Sheridan, mine inspector, who after the latter part of January was assisted by J. W. Groves, assistant mining engineer.

G. S. Rice, assisted by A. C. Ramsey and R. Y. Williams, assistant mining engineers, during the year examined a number of mines in Pennsylvania, West Virginia, Ohio, and Illinois, where explosions or mine fires have occurred, and investigated the influence of moisture from sprinkling or steam, etc., as a means of preventing dust explosions in mines. In this work Mr. Rice was joined by J. W. Groves in January, 1909; J. J. Rutledge in March, 1909; and H. M. Wolflin June 6, 1909.

J. W. Paul, assisted by F. F. Morris, F. W. Horton, and L. N. Jones, assistant mining engineers, has conducted investigations into the different systems of lighting mines and the efficiency of different types of rescue apparatus for use in entering mines filled with poisonous gases, and supervised the training of practical miners to use the rescue apparatus with a view to assisting in these investigations in the different coal fields. One day of each week was devoted to giving public demonstrations of the use of the rescue apparatus and of the training in its use of miners sent in for this purpose from the different mining regions.

As soon as the appropriation for this work became available, the necessary equipment for the investigation of explosives used in coal mining was ordered, and much of this was in place and ready for use at the beginning of the fiscal year. Clarence Hall, explosives engineer, with S. P. Howell, assistant engineer, and E. L. Stenger and A. B. Coates, junior engineers, conducted during the first six months of the year the preliminary tests of explosives with a view to training men in the adjustment of the equipment connected with the large testing gallery. This work was supplemented by tests by C. H. Cordie, assistant chemist, and H. M. Wolflin and F. F. Morris, assistant engineers, concerning the various physical properties of explosives. The chemical analysis of explosives and of the gases resulting from explosions of natural gas, coal dust, and other materials used in conducting the investigations was carried on throughout the fiscal year under W. O. Snelling, assistant chemist, in charge, aided by C. G. Storm, A. L. Hyde, H. Schlatter, W. C. Cope, and G. A. Burrell.

Early in the fiscal year the general equipment of the Pittsburg station was increased by a portion of the apparatus needed for the investigations into the uses of electricity in mining and its relations to mine explosions, and certain investigations into this subject were begun. The electric engineer in charge of these investigations, H. H. Clark, was appointed April 1, and continued in service through the remainder of the fiscal year. He has been assisted by L. M. Jones, junior engineer, and G. R. Wood, consulting engineer.

R. Y. Williams, assistant mining engineer, was during March, April, May, and June stationed at Urbana, Ill., in charge of a mine rescue station established there under a cooperative arrangement between the Illinois State Geological Survey, the University of Illinois, and the United States Geological Survey. During April, May, and June A. C. Ramsey was stationed at Birmingham, Ala., for the special purpose of investigating the causes of mine explosions in that region and the best methods of preventing them.

RESULTS OF INVESTIGATIONS.

Among the results of this work may be mentioned the establishment of a well-equipped laboratory and testing station at which there have been made during the fiscal year more than 1,000 chemical analyses of explosives used in mining, and of natural gas, coal dust, and various explosion products, and nearly 5,000 physical tests of explosives in the gas and dust galleries; a large number and variety of mine lamps have been examined; and experiments have been made with a number of different types of mine rescue apparatus. Some 40 inspection trips have been made to explosives manufacturing plants with a view to investigating the different types of explosives used in mining.

In January, 1909, the manufacturers of explosives used in coal mines were invited to bring to the testing station at Pittsburg such explosives as they desired to have tested with a view to their use in mines where explosive gases and inflammable dust were known to occur under conditions indicative of danger. In response to this invitation 28 requests were received for the testing of 61 explosives, of which, up to the end of the fiscal year, 31 have been tested. Of these, 18 have passed all the tests satisfactorily and have been placed on what is designated the "permissible list" of explosives for use in such mines. On May 15 a circular (No. 1) was distributed to persons interested in coal mining, giving the names of the 17 explosives which at that date had passed all the tests and had been placed on the permissible list.

The engineering force for the investigation of mine conditions in relation to explosions has during the year visited 54 mines, representative of the several important coal fields—especially the mines which were considered dangerous owing to the presence of gas and dust and in which either mine explosions or mine fires occurred. At 14 of these explosions had occurred and at a number of others fires were raging which could not be easily extinguished except through the use of the special breathing apparatus with which these mining engineers were equipped.

Many tests have been made as to the type of lamps and of electric equipment of various kinds which may or may not be used safely in mines containing gas or inflammable dust under conditions likely to cause mine explosions.

The value of moisture in coal dust in preventing dust explosions in mines has been demonstrated in a series of laboratory investigations, which it has been arranged to supplement by tests made underground with actual mining conditions. Another series of investigations has demonstrated the conditions under which the use of improper explosives and the improper use of any explosive may cause a dust or gas explosion. The use of a small coal mine has been obtained in which it has been arranged to conduct a series of experiments concerning the influence of moisture and explosives in causing mine explosions, thus repeating under actual mine conditions the experiments conducted in the laboratory.

FUEL DIVISION.

ORGANIZATION.

The organization of the fuel division is practically the same as during the preceding fiscal year. Its work comprises the analyzing and testing of the fuels belonging to or for the use of the United States and general investigations with a view to the increased efficiency or the prevention of waste in the mining and use of coal and other mineral-fuel substances. The equipment was practically the same as that used during the investigations of the preceding year at Norfolk, Va., except that a 250-horsepower Taylor producer and a 250-horsepower vertical three-cylinder Westinghouse gas engine, used at Norfolk, were replaced by a 150-horsepower Loomis-Pettibone producer and a 150-horsepower vertical three-cylinder Westinghouse gas engine; with this equipment was installed in government building No. 17 on the arsenal tract at Pittsburg a special combustion chamber 40 feet long with a 150-horsepower mechanical stoker, attached to one of the 220-horsepower Heine boilers, with a view to conducting special investigations into combustion problems.

In the chemical section N. W. Lord continued to serve as consulting chemist, with general supervision over all chemical work. The work of the laboratory in making general coal analyses remained under the immediate supervision of F. M. Stanton, chemist, assisted by A. C. Fieldner, G. A. Burrell, I. H. Bower, D. I. Brown, E. M. Dawson, jr., W. W. Karnan, B. G. Macintire, C. J. Monahan, J. A. Scherrer, R. E. Vennum, Perry Barker, and W. E. Surbled, assistant chemists. The routine work of the section included the determination of the heat value and chemical composition of samples of coal collected from public lands throughout the West.

H. C. Porter, assisted by F. K. Ovitz, continued during the year the special chemical investigations concerning the nature of the gases given off in the distillation of typical coals at different temperatures, the character and fuel value of the volatile matter given off from these coals, and the nature and possible prevention of spontaneous combustion of coals.

J. C. W. Frazer continued his special laboratory researches into the chemistry of the combustion of coals in the different types of furnaces used in government heating and power plants and into the methods of dissolving the hydrocarbons in coal, with a view to their complete chemical analysis.

I. C. Allen, assisted by C. C. Draper and W. A. Jacobs, has continued during the year his chemical and physical examinations into the character and fuel value of the different varieties of crude petroleum, concerning which information was desired by the Navy, Treasury, and Interior Departments.

J. K. Clement, assisted by L. K. Adams, cooperated with Doctor Frazer and Henry Kreisinger in the investigation of special combustion problems, and also assisted W. T. Ray in certain boiler-furnace investigations, C. L. Wright in certain briquetting investigations, and R. L. Humphrey in certain structural-materials investigations.

The fuel-efficiency investigations in connection with heating and power plants of the Government, with a view to determining the fuels best adapted for use for these purposes in different parts of the country and the methods by which they may be used most efficiently by the Government, were conducted under the advisory supervision of R. H. Fernald, L. P. Breckenridge, and W. F. M. Goss, by D. T. Randall, H. W. Weeks, S. B. Flagg, Henry Kreisinger, W. T. Ray, and the assistant engineers.

Special lines of investigation were followed under this section in connection with the testing of fuels under boiler furnaces, such as are used in government power and heating plants, under D. T. Randall, H. W. Weeks, and S. B. Flagg; the investigation of gas fuels under producer furnaces as to their adaptability for naval purposes and for utilizing the low-grade bituminous coals and lignites, such as are found on the public lands, under the supervision of R. H. Fernald, assisted by C. D. Smith, D. F. Smith, L. Stone, and F. E. Woodman; the investigation of fuel oils as to their chemical and physical properties, with a view to determining the most efficient methods of use, under I. C. Allen, and as to their availability for use in fuel engines, under R. M. Strong; the investigation of combustion problems with reference to furnaces for government heating and power plants, under Henry Kreisinger, W. T. Ray, J. C. W. Frazer, and J. K. Clement; investigations into the briquetting, coking, and washing properties of coal, under A. W. Belden and G. R. Delamater at Denver, Colo., July to December, 1908, inclusive, and under C. L. Wright at Pittsburg, January to June, 1909; and heat-propagation investigations under W. T. Ray and Henry Kreisinger.

In connection with the investigation of fuels for the War Department, the small boiler and equipment which for several years has been in use in that department under the direction of the Quartermaster-General of the Army near Washington was early in May shipped to the Pittsburg station, and at the same time the assistant engineer in charge, A. S. Rowe, was transferred to the Survey to continue in charge of this plant, which will hereafter be operated as part of the equipment of the technologic branch.

W. T. Ray has devoted his attention largely to experiments connected with heat transmission in furnaces such as are used by the Government for power and heating purposes. Charles L. Wright during the latter half of the fiscal year continued experiments looking to the briquetting of lignites without the use of external binding materials, and succeeded in making briquets of lignites from four different localities in the Western States. Otto Lehman, of Magdeburg, Germany, was employed during the months of April and May to aid in the installation and operation of the large German briquetting machine.

A. W. Belden and G. R. Delamater continued washing and coking investigations at Denver and the preparation of a report on them until February. At that time Mr. Delamater resigned and Mr. Belden was transferred to the Pittsburg plant, where he cooperated with Mr. Wright in the lignite-briquet investigation.

The inspection of fuels used by the Government was under the supervision of J. S. Burrows from the beginning of the year to March 16, and subsequently under G. S. Pope. It embraced the drawing up of specifications for use in the purchase of coal used by the Government in its heating and power plants in the city of Washington and elsewhere, and the sampling and testing of fuels delivered to the Government in different parts of the country. Mr. Burrows and Mr. Pope were assisted in this work by P. M. Riefkin, N. H. Snyder, E. W. Miller, L. Loeb, A. A. Straub, and F. J. Simington, assistant engineers, and J. W. Peters, junior chemist. The samples of coals collected by the inspecting force or sent in from different parts of the country by local representatives of the Government were analyzed in the Washington laboratory under S. S. Voorhees, aided by G. O. Spitler and J. D. Davis, chemists, and H. M. Cooper, J. S. McCune (after Nov. 4, 1908), A. C. Cooper (after Dec. 20, 1908), W. J. Buttner (after Feb. 9, 1909), Wood Freeman (after Mar. 11), J. A. Scherrer (after May 17), and H. G. Elledge (after June 21), assistants.

FIELD INVESTIGATIONS.

The field work of the fuel division during the fiscal year consisted of investigations into the chemical and microscopic structure of coal, with reference to its origin and its coking qualities, conducted by David White, assisted by Rhinehard Thiessen; field investigations into the character and distribution of peats and certain lignitic coals, conducted by C. A. Davis; and the inspection of coals in connection with government purchases, conducted by Messrs. Burrows, Pope, and Rice, and other mining engineers.

RESULTS OF INVESTIGATIONS.

Among the results of the fuel investigations conducted during this and the preceding fiscal year is the fact that the purchase of nearly half the coal used by the Government is based on some form of specifications prepared by the technologic branch of the Survey. During the present year 3,299 samples of coal have been collected, 19,727 chemical and calorimeter determinations have been made, and more than 100 mines have been examined with a view to determining the possibility of obtaining coal deliveries in accordance with proposed contracts. For the government coals purchased without definite specifications the fuel division is making, at the request of different branches of the government service, examinations of the mines from which it is expected that this coal will be delivered, and also from time to time chemical analyses and calorimeter tests of the coal delivered, with a view to determining whether or not the deliveries are in accordance with the contracts under which the purchases are made.

The special chemical investigations have made known the character and value of the coal underlying several million acres of public land, have thrown light on the properties of coal and processes of combustion, and will aid in rendering possible increased efficiencies in the burning of coal. The investigations at Denver have shown the possibilities of making commercial coke for metallurgical purposes from the coal of a number of coal fields which were not heretofore believed to yield coking coal, and have indicated how the quality of this coke may be decidedly improved through washing processes. The briquetting investigations have demonstrated the possibility of making commercial briquets from lignites collected at two localities in Montana, one in California, and one in Texas.

In connection with the producer investigations during the latter half of the fiscal year 15 tests have been made, ranging from sixty to one hundred and thirty-nine hours each, involving nearly 40,000 observations. In the investigations of the use of fuel oils for power purposes 234 tests were made, involving some 2,500 observations. Under the investigations into fuel efficiency for government heating and power plants 60 tests have been made, involving 31,500 observations, the tests relating primarily to coals for use by the Quartermaster's Department of the Army.

F. M. Stanton and his assistants at the Pittsburg laboratory analyzed 1,365 samples of coal, involving more than 20,000 determinations. These samples were forwarded from different departments of the Government and to a large extent collected from the public land.

In the investigation of the coals from the public lands in the Rocky Mountain region during the first half of the fiscal year 69 coking tests, 49 washery tests, and 532 chemical analyses were made, involving 3,253 calorimeter and other determinations.

The total cost of these investigations is but a small percentage of the aggregate financial value of these results to the Government itself, through increase in value of its coal lands and through greater economy in purchasing and greater efficiency in using fuels.

STRUCTURAL-MATERIALS DIVISION.

ORGANIZATION.

Investigations under the structural-materials division during the fiscal year had a double purpose—(*a*) to determine the nature and extent of and the most efficient methods of utilizing the structural materials belonging to and for the use of the Government of the United States; (*b*) to investigate such materials with a view to determining their suitability for the special purposes for which their use is proposed in the building and engineering construction work of the Government. The organization of this work was much the same as during the preceding year, with the addition of the clay-products section. Investigations were conducted during the year not only at the central experiment station at Pittsburg and the structural-materials laboratory at St. Louis, but also at the special laboratories at Atlantic City, N. J., Northampton, Pa., and Washington.

Under the immediate direction of R. L. Humphrey investigations in concrete and reinforced concrete were continued by L. H. Losse, with the aid of five assistant engineers and skilled laborers at the St. Louis laboratory in Forest Park; investigations into the fire-resisting properties of structural materials were continued by E. B. Tolsted at Chicago and later at Pittsburg, and investigations into the behavior of reinforced concrete beams under static loads were made by Mr. Tolsted at Pittsburg during May and June.

The chemical researches associated with structural-materials investigations were conducted by P. H. Bates, assisted by A. J. Phillips, at Pittsburg, and by S. S. Voorhees, with J. S. Miller, L. M. Law, A. C. Nothstine, and W. Freeman, assistant chemists, in the laboratory at Washington.

Investigation of clays and clay products for use in government buildings and engineering construction work were conducted in the structural-materials laboratory at Pittsburg by A. V. Bleininger, assisted by H. E. Ashley, G. H. Brown, and E. Thomas. Mr. Bleininger has also supervised the investigation of lime for use in government buildings, in which he was assisted by W. E. Emley.

The field investigations of stone, sand, gravel, and associated structural materials available for use in the construction of government buildings and other public works were carried on by E. F. Burchard at intervals throughout the larger part of the year, and by N. H. Darton in the Middle and South Atlantic States during April, May, and June. These investigations have been made at the special request of the Secretary of the Treasury for the Supervising Architect, with a view to determining the nature and extent of the structural materials for use in more than 300 public buildings provided for by Congress during the last two years. For a number of public buildings these materials have been carefully examined in the field, and samples of the different types of sand, gravel, crushed stone, clay products, etc., available for use in the construction of these buildings have been forwarded to the laboratories at St. Louis and Pittsburg, where they have been carefully tested as to their suitability for such use.

The investigations into the behavior of concrete exposed to water and into the methods of counteracting the injurious influence, which were undertaken at the request of the War and Navy departments, have been conducted at the marine structural-materials laboratory at Atlantic City, N. J., by R. J. Wig, under the supervision of Mr. Humphrey. Investigations as to the causes and methods of preventing injuries to concrete from alkaline waters in the arid States are being carried on at the Pittsburg station.

The testing of cement shipped to Panama was done in the well-equipped laboratory at Northampton, Pa., where the cement is being manufactured. W. A. Campbell, with six assistants, was in charge of the work. Investigations conducted at the Washington laboratory related to the structural materials purchased for use by the several branches of the government service in Washington, especially the cement and other structural materials purchased for use by the Supervising Architect in the construction and repairs of government buildings. The laboratory formerly maintained by the Supervising Architect for testing materials purchased for use in the construction and maintenance of public buildings was transferred from the Treasury Department to the Department of the Interior in November, 1908. This laboratory was associated with the Washington laboratory of the technologic branch and S. S. Voorhees, as engineer of tests, was placed in charge of both.

RESULTS OF INVESTIGATIONS.

Among the results of the structural-materials investigations during the fiscal year may be mentioned the making of nearly 6,000 and the testing of nearly 4,000 forms of constituent materials (sands, gravels, stone, etc.); the making of more than 400 and the testing of more than 700 beams; and the making of 78 and the testing of 54 samples of steam-cured forms, mainly for the Supervising Architect and for the Quartermaster-General and Chief of Engineers of the Army.

In addition to the above, analyses have been made of 630 different samples of structural materials, involving nearly 9,000 chemical determinations. In the testing of cement shipped from Northampton, Pa., for the Isthmian Canal Commission 2,207 determinations were made, including the time of set, specific gravity, fineness, etc., and at the close of the fiscal year the testing of this cement was proceeding at the rate of 2,000 barrels a day. In connection with the testing of structural materials for departmental purchases in the District of Columbia nearly 3,000 samples were received for analysis, involving nearly 33,500 chemical determinations and tests. A number of miscellaneous investigations have been carried on during the year at the request of the Supervising Architect's office, Isthmian Canal Commission, Corps of Engineers of the Army, Bureau of Yards and

Docks of the Navy, and Reclamation Service relative to the waterproofing of concrete and other engineering structures; the reinforcing and protection of concrete; the relative strength and durability of columns of concrete, brick, terra cotta, and other structural materials; the behavior of clays and clay products under different conditions; and the fire-resisting qualities of different structural materials.

PUBLICATION BRANCH.

BOOK-PUBLICATION DIVISION.

SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 6 professional papers, 36 bulletins (one of which was also published in 3 separate chapters), and 12 advance chapters from one other bulletin, 12 water-supply papers, 1 annual report on mineral resources for 1907 (also published in 50 chapters), 6 advance chapters from the annual report on mineral resources for 1908, and 7 geologic folios. These publications were the Twenty-ninth Annual Report; Professional Papers 58 to 63; Bulletins 340, 341, 345 to 359, 361 to 376, 378, 379, 12 separates from 380, and 385; Water-Supply Papers 219 to 226 and 228 to 231; Mineral Resources for 1907 (volume and 50 separate pamphlets) and 6 separate chapters from Mineral Resources for 1908; Geologic Atlas, folios 160 to 166. Summaries of these publications are given on pages 17–28 of this report. They comprise 10,180 pages, those of the last fiscal year covering 10,149 pages. In addition to the publications of the regular classes a "Handbook for field geologists," a revised edition of "Geographic tables and formulas" (formerly issued as Bulletin 234), a pamphlet of "Suggestions to authors of papers submitted for publication by the United States Geological Survey, with directions to typewriters," and many miscellaneous circulars and pamphlets, most of them relating to administration, were published.

During the year 19,775 pages of manuscript were prepared for printing, and proof sheets for 11,840 final printed pages were read and corrected, this work involving the handling of 4,139 galley and 23,748 page proofs. The corresponding figures for last year were 20,691 pages of manuscript, 10,827 final printed pages, 4,479 galley proofs, and 16,140 page proofs.

The make-up was prepared for 538 plates, the proofs of which were also read, as against 369 plates so prepared last year.

Indexes were prepared for 47 publications, covering 9,730 pages, the corresponding figures for last year being 39 publications and 7,538 pages.

George M. Wood, editor, has charge of the work of this section, and 5 other persons have been employed during the year. Material assistance has been rendered at different times in the work of the section of distribution.

SECTION OF ILLUSTRATIONS.

During the year 5,171 illustrations were prepared for 41 bulletins, 14 water-supply papers, 5 professional papers, 2 reports on mineral resources, and 1 annual report. These illustrations included 181 maps, 956 diagrams, 3,222 paleontologic drawings, 629 photographs retouched, and 183 miscellaneous.

Proofs to the number of 1,745 were received and compared critically, and an examination was made of the printed editions of all illustrations furnished by contract during the year, as heretofore.

During the year 109 electrotypes were furnished to outside applicants, as compared with 182 furnished last year.

The committee on illustrations rejected 149 illustrations submitted with manuscripts offered for publication.

At the close of the year material for the illustration of 27 reports is in hand.

At present the personnel consists of 4 geologic draftsmen, 3 paleontologic draftsmen, 1 classified laborer, and the draftsman in charge.

SECTION OF GEOLOGIC MAPS.

During the year a change in the form of the geologic folio has been made to meet the demand of the practical user of the maps in the field. In addition to the large folio form, which is inconvenient to carry about, a field edition of octavo size with folded maps in a pocket will hereafter be published for all, and the last three folios published during the fiscal year appear in this form as well as in the other.

Besides the preparation of folios for publication and reading proof, the section of geologic maps has been engaged in the preparation of the geologic map of North America and other geologic data for publication in reports other than folios of the geologic atlas.

Of the 10 folios in hand July 1, 1908, seven were published during the fiscal year (see pp. 27–28) and the three others—Trenton (N. J.-Pa.), Mercersburg-Chambersburg (Pa.), and Watkins Glen-Catatonk (N. Y.)—are very nearly completed. The Jamestown-Tower (N. Dak.), Warren (Pa.), Engineer Mountain (Colo.), Sewickley (Pa.), and Johnstown (Pa.) folios, which were transmitted to the section during the year, are in course of publication.

SECTION OF TOPOGRAPHIC MAPS.

A year ago the editor of topographic maps reported 54 new topographic atlas sheets and special maps which had not yet been put into the hands of the engravers and 37 in process of engraving. The corresponding figures on June 30, 1909, were 76 and 59. The accessions during the year numbered 103 maps; 85 maps were published.

The manuscripts edited, including verification or correction of all geographic names, comprise 83 new atlas sheets and special maps; corrections for 224 sheets hitherto published; and 214 map illustrations which are or will be included in 35 volumes of Geological Survey reports. The proof read comprises 78 new atlas sheets and special maps and corrections to 66 maps.

Compilations were made for a revision of the western half of the large United States base map to provide a base for a map of the mining districts of the western United States, published in Mineral Resources, 1907. Additional material was compiled for the base "Carte géologique de l'Amérique du Nord." For the Department of the Interior, three administrative maps—"Yosemite National Park," "Sequoia and General Grant National Parks, Cal.," and "Platt National Park, Okla."—were prepared. The first two, being made up of extracts from Geological Survey atlas sheets, were prepared and proof read in this section; the last—surveyed, engraved, and printed by the Geological Survey—received the same attention in the way of editing and proof reading as any Survey map.

Five men were engaged in the work of this section during the entire year.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 127 new books, 7 new folios, 85 new maps, and 204 reprints of maps, a total of 423; the totals of all editions were 360,472 books, 34,971 folios, and 773,607 maps; grand total 1,169,050. During the year 360,616 books, 39,170 folios, and 597,361 maps (including 444,230 sold), a total of 997,147, were distributed.

The total amount received and turned into the Treasury as a result of sales of publications was $19,899.28, an increase of $2,885.72 over the amount received during the year 1907–8.

During the year 79,315 letters were received, answered, and filed, an increase of 2,645 over the number in the preceding year.

DIVISION OF ENGRAVING AND PRINTING.

MAPS, FOLIOS, AND ILLUSTRATIONS.

At the beginning of the year 117 atlas sheets and special maps were on hand for publication and the accessions during the year were 103 maps. The status of these 220 maps on June 30, 1909, was as follows:

Published during the year	85
In process of engraving	59
Not taken up	76

Besides the engraving of new maps, corrections were made on the plates of 228 maps hitherto published. Editions of 289 maps were printed and delivered to the map room, including new maps and reprints or new editions.

Seven geologic folios were published and 34,971 copies were printed. Eight other geologic folios had been partly completed at the close of the year.

Under contracts with the Government Printing Office, map illustrations were printed for the following Survey publications: Bulletins 349, 351, 356, 358, 360, 364, 371, 374; Water-Supply Papers 220, 221, 222, 224, 225, 231; Mineral Resources, 1907. For the Government Printing Office, also, maps of 13 bird reservations, 2 national monuments, 8 national forests, and some odd items were printed and delivered; for the Forest Service, maps of 54 national forests, the "Forest Service Atlas" for 1907, the "Forest Atlas legend plate," and a map of the United States showing all the national forests; for the General Land Office, 1,091 township plats; for the Department of the Interior, maps of three national parks and a number of maps for exhibition at the Alaska-Yukon-Pacific Exposition; for the Reclamation Service, a large amount of miscellaneous work.. Work was also done for the War Department, the Cuban Government, the Weather Bureau, the Bureau of Standards, the Isthmian Canal Commission, the Bureau of Education, the Office of Indian Affairs, the Civil Service Commission, and the Biological Survey. This work for other branches of the Government amounted to about $45,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Of miscellaneous matter of all kinds the total number of copies printed was nearly a million and a third and required nearly three and one-half million printings. The total number of copies printed of maps, folios, and miscellaneous matter was 2,123,973, requiring over eight and one-half million impressions. On requisition of the Government Printing Office, 212 transfer impressions were made and shipped to contracting printers.

INSTRUMENT SHOP.

The work of the instrument shop consisted in overhauling and repairing surveying, drafting, and engraving instruments and in making copperplates and electrotypes. More than 2,700 repairs were made to instruments and 258 new copperplates and 37 electrotypes were finished.

PHOTOGRAPHIC LABORATORY.

The output of the laboratory included 18,199 negatives, of which 3,172 were wet, 1,148 paper, and 13,879 dry; 38,935 prints, of which

12,270 were chloride prints, 692 bromides, and 25,973 prints for illustrations; and 1,147 lantern slides made and 131 colored.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

Correspondence, records, appointments, supplies, and shipments.—The work of this section was considerably heavier during 1908–9 than in the preceding year, as shown by the figures given below. The general character and scope of the work and the routine of carrying it out have been the same, with the exception of an important change in the work of the appointment desk. In compliance with the department order of January 15, 1909, all papers in connection with the personnel are prepared in this section. This change not only involves the preparation of all appointment papers in this office, but it allows direct communication with the Civil Service Commission in all matters preliminary to appointments. It also puts upon this section the duty of preparing reports to the Treasury, through the disbursing clerk, of all changes in the personnel affecting pay, and also the preparation of reports to the Civil Service Commission each month of all changes in the personnel. While these changes have all served to expedite the accomplishment of results, they have added very much to the work of the section. This condition has been recognized by the Department, and it has detailed a clerk expert in appointment matters to assist in the work.

Mails, files, and records.—During the year 121,351 pieces of incoming mail were handled in this section, a gain of more than 13 per cent over the preceding fiscal year. The increase in 1908 over 1907 was but 2 per cent. Of this mail, 25,258 pieces, an increase of 25 per cent over the number for 1908, contained remittances for publications of the Survey. The amount of money received in this mail was $22,546.33.

The recording, referring, and filing of correspondence required most of the services of four clerks throughout the greater part of the year. The number of letters mailed through the section was 91,450, of which 17,333 were registered. This is an increase of about 37 per cent over 1908 in the total number of pieces mailed and practically the same in the outgoing registered mail.

Personnel.—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 955 persons, an increase of 115, or 14 per cent, over the preceding year. In this roll 1,322 changes, including appointments, separations, promotions, and changes of status of every kind, were made during the year, which was an increase over the preceding year of nearly 45 per cent and is more than in any previous year in the Survey's history. Of these changes 390 were new appointments, an increase of 16 per cent; 275 were separations (including 6 caused by death); 432 were promotions; and 3 were reductions. The remaining changes included extensions of limited appointments, changes in titles or in the basis of payment, the designation of disbursing agents, and such other minor changes as neither increased nor decreased the total number of persons.

In the foregoing no account is taken of the cases of temporary employment based on authorization from the Civil Service Commission. In this class of cases there is no Secretarial appointment, the work being essentially correspondence, with a temporary record of the particulars of the case.

During the year 13,890 days of annual leave and 2,763 days of sick leave were granted, being 49 per cent of the amount of annual leave and 10 per cent of the amount of sick leave which it is permissible to grant under the law; also 6,866 days of leave without pay. In addition to the above there were also 134 transfers to state pay rolls, in cooperative work.

Property accountability.—During the year the system of property accountability by custodians for various branches and divisions was continued and, in addition, a custodian of office property was designated to make an inventory of all nonexpendable property in Washington. This inventory was completed, and a list of the office property submitted to the Department near the close of the calendar year 1908.

Express and freight.—During the year 3,313 pieces of freight and express were handled by the shipping clerk, of which 1,109 were outgoing and 2,204 were incoming; 716 freight and express accounts were examined and checked. This is a decrease of 30 per cent in the number of pieces handled, but an increase in the number of accounts handled.

Purchase and distribution of supplies.—The system of employing a general purchasing clerk to look after the details of all purchases made in Washington, established during the previous year, was continued and is working satisfactorily. The work of procuring bids, issuing orders, and preparing vouchers required the services of three persons during the entire year. The number of requisitions handled during the year was 2,847, an increase of 28 per cent over the preceding year. The number of orders drawn was slightly less and the number of vouchers passed considerably more than in the preceding year.

Stationery.—In the stationery room the services of three men are required for handling mails, delivering supplies throughout the office and packing and shipping them to the field parties, and keeping an account of the charges for stationery supplies. During the year

9,043 requisitions for blanks, blank books, and miscellaneous supplies were filled from stock on hand and 442 requisitions were drawn on the Department for supplies. In addition to this work 677 requisitions for printing were made on the Department and 424 requisitions for furniture and supplies. These figures are, with one exception, slightly larger than for the previous year. The practice of limiting the dates on which requisitions may be forwarded has reduced the number of requisitions since the order went into effect, which accounts for the apparently small increase in this phase of the work in the stationery room.

Administrative bookkeeper.—Throughout the year the administrative bookkeeper continued to handle all Survey transactions of an administrative character and to examine, check, and record such items as related solely to the administrative branch. He acted in an advisory capacity with respect to accounting methods of the branch, passed on all requisitions for supplies to be procured from the Department of the Interior, determined the amount payable therefor from Survey appropriations, and arranged and submitted for settlement the accounts covering charges arising for these purposes.

The following table shows the classified net disbursements by the Survey for the fiscal year 1909, the repayments shown in the table on page 119 having been deducted:

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1909.

Appropriation.	Total.	Salaries and wages.	Traveling expenses.	Rent, electric light, and motive power.	Office furniture and fixtures.	Stationery supplies.	Library.	Transportation of property.	Instruments.	Telegrams and telephone service.
Salaries, statutory	$64,505.62	$64,505.62								
Skilled laborers, etc	19,794.32	19,794.32								
Gaging streams, etc	99,545.94	77,654.53	$9,838.62	$1,629.82	$922.31	$1,004.17		$575.55	$1,913.03	$266.11
Paleontologic researches	9,989.75	9,293.40	333.09	5.35	74.58	37.45		9.00	8.55	19.27
Chemical and physical researches	19,497.93	17,566.87	.70	87.94	223.45	63.40		14.45	2.25	
Preparation of illustrations	18,066.75	16,664.04	2.80	2.52	85.50	87.34				6.68
Mineral resources of the United States	74,507.27	63,458.53	3,761.46	532.87	1,860.00	1,566.99	$2.70	105.28	281.72	489.13
Books for the library	1,396.84						1,375.47	21.37		
Topographic surveys	296,338.31	187,239.08	23,714.50	211.98	559.30	3,891.56	4.40	4,796.77	2,875.64	510.74
Geologic surveys	199,340.58	157,128.66	13,658.94	136.05	2,285.58	1,519.13	9.75	1,499.35	1,423.89	210.31
Mineral resources of Alaska	79,418.87	42,722.58	14,228.61	5.05	216.77	663.91		4,849.13	867.55	89.33
Geologic maps of the United States	87,188.83	59,823.31	66.50	1,907.42	395.26	240.10		124.14		87.71
Surveying forest reserves	74,517.88	61,089.12	1,949.94	25.45	122.32	376.16		150.11	82.42	12.00
Testing fuel	246,914.87	164,860.86	9,160.59	2,514.70	2,323.77	1,306.68	105.60	4,651.51	63.30	407.89
Testing structural materials	78,255.79	46,181.44	2,712.63	358.13	455.84	456.74	79.68	1,164.32	10.92	94.30
Inspecting mines in territories	3,185.98	2,000.00	809.02							.55
Investigating mine accidents	148,226.90	34,185.68	4,293.97	193.63	2,193.72	714.10	50.61	1,045.82	493.62	296.24
Improving and safeguarding electric wiring	1,999.53	915.67			1,083.86					
Replacing articles destroyed by fire	14,309.22	1,283.00	259.73		4,266.03	466.46		5.75	6,013.18	
	1,537,001.18	1,026,366.71	84,791.10	7,610.91	17,068.29	12,394.19	1,628.21	19,012.55	14,036.07	2,490.26

Appropriation.	Camp outfit.	Subsistence.	Forage.	Photographic material.	Engraving and printing material.	Chemical and physical laboratory material.	Drawing material.	Control material.	Erection of testing plants.	Operation of testing plants.
Salaries, statutory										
Skilled laborers, etc										
Gaging streams, etc	$777.04	$3,386.28	$638.87	$649.27		$283.60	$6.74			
Paleontologic researches	13.50	3.00	10.45	127.32		54.79				
Chemical and physical researches				9.40		1,529.47				
Preparation of illustrations				962.85			255.02			
Mineral resources of the United States	6.35	1,448.00	6.50	372.72		614.01	1.01			
Books for the library										
Topographic surveys	6,616.11	44,870.06	15,834.74	2,723.78		28.88	309.15	$2,151.62		
Geologic surveys	3,064.93	9,637.25	2,615.77	5,149.37		731.63	269.97			
Mineral resources of Alaska	6,107.41	7,589.41	1,100.78	740.67		114.85	105.87	16.95		
Geologic maps of the United States		20.10			$24,524.29					
Surveying forest reserves	2,165.31	2,980.20	3,087.77	2,266.12		6.03	91.72	113.21		

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1909—Continued.

Appropriation.	Camp outfit.	Subsistence.	Forage.	Photographic material.	Engraving and printing material.	Chemical and physical laboratory material.	Drawing material.	Control material.	Erection of testing plants.	Operation of testing plants.
Testing fuel	$120.75	$5,779.71	$164.63	$616.16		$10,902.81	$51.95		$35,802.18	$8,081.78
Testing structural material	2.25	1,442.00	.50	106.90		6,064.65	20.80		16,978.92	2,125.77
Inspecting mines in the Territories		375.71	.70							
Investigating mine accidents	16.65	2,381.36		465.00		8,965.35	125.06		88,785.14	4,020.95
Improving and safeguarding electric wiring										
Replacing articles destroyed by fire	76.55	95.20	18.00	5.75		1,634.05	89.89	$95.63		
	18,966.85	80,008.28	23,478.71	14,195.31	$24,524.29	30,930.12	1,327.18	2,377.41	141,566.24	14,228.50

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ended June 30, 1909.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of the Director	$35,340.00	....	$35,340.00	$34,772.34	$567.66
Salaries, scientific assistants	29,900.00	....	29,900.00	29,733.28	166.72
Skilled laborers, etc	20,000.00	....	20,000.00	19,794.32	205.68
Gaging streams	100,000.00	$31,261.00	131,261.00	130,806.94	454.06
Paleontologic researches	10,000.00	....	10,000.00	9,989.75	10.25
Chemical and physical researches	20,000.00	....	20,000.00	19,497.93	502.07
Preparation of illustrations	18,280.00	....	18,280.00	18,066.75	213.25
Mineral resources of the United States	75,000.00	26.56	75,026.56	74,533.83	492.73
Books for library	2,000.00	.35	2,000.35	1,397.19	603.16
Replacing articles destroyed by fire	15,810.00	....	15,810.00	14,309.22	1,500.78
Improving and safeguarding electric wiring system	2,000.00	....	2,000.00	1,999.53	.47
Topographic surveys	300,000.00	39,991.25	339,991.25	336,329.56	3,661.69
Geologic surveys	200,000.00	34,178.07	234,178.07	233,518.65	659.42
Mineral resources of Alaska	80,000.00	.45	80,000.45	79,419.32	581.13
Geologic maps of United States	100,000.00	67,076.37	167,076.37	154,265.20	12,811.17
Surveying forest reserves	75,000.00	111.28	75,111.28	74,629.16	482.12
Testing fuel	250,000.00	827.46	250,827.46	247,742.33	3,085.13
Testing structural materials	100,000.00	5,023.46	105,023.46	83,279.25	21,744.21
Inspecting mines in Territories	7,350.00	....	7,350.00	3,185.98	4,164.02
Investigating mine accidents	150,000.00	2,707.50	152,707.50	150,934.40	1,773.10
	1,590,680.00	181,203.75	1,771,883.75	1,718,204.93	53,678.82

LIBRARY.

The library received during the year 11,761 book publications and 512 maps. This includes all purchases made with the appropriation of $2,000 and all material received by exchange and gift. The publications of scientific societies and of state and national surveys are procured by exchange whenever possible, the library funds being reserved to purchase the necessary scientific periodicals, reference books, monographs published independently, and out-of-print publications, particularly paleontologic works, which are needed to complete the Survey sets. A number of valuable works have been presented by their authors. About 2,000 pamphlets were received from Prof. Charles Schuchert, of Yale University. The library now contains 64,084 numbered volumes exclusive of the unbound periodicals received during the year. All new material is placed on the exhibition shelves for one week, thus enabling those who so desire to keep posted on the new literature.

The persons consulting books and maps in the library during the year numbered 8,717. Besides this, 9,460 books and 528 maps were loaned for use outside of the library.

The cataloguing of current accessions has been kept up to date and the publications of the geological surveys of Great Britain and of the Australian States (about 1,500 items), of which the library has nearly full sets, have been completely catalogued. These catalogue entries have been sent to the Library of Congress, where they are printed on cards which are placed on sale. As in previous years, the Survey library has continued to furnish to the Library of Congress catalogue entries of geologic books. Librarians and others interested in making geologic collections are by the use of these cards relieved of the labor of cataloguing. Sets of these titles, which may be had from the Library of Congress, form the only complete, up-to-date list in existence of the publications of national and state surveys.

The alphabetical subject catalogue now includes about 8,500 cards and is progressing at the same rate as the author catalogue.

The exchange list, which is supervised in the library, includes the names of 835 libraries, of which 260 are in the United States and 575 in foreign countries. These libraries receive all book publications of the Survey as issued. They are chiefly those maintained by scientific societies and institutions, by universities, and by government bureaus devoted to mining and geologic research. Persons are not included in this exchange list and no list is maintained of persons to whom all the Survey publications are regularly forwarded. Individuals receive only such publications as they request. During the year 37 bulletins, 10 water-supply papers, 7 professional papers, the Twenty-ninth Annual Report, Monograph XLIX, and Mineral Resources for 1907, in all 58 volumes, were issued to regular exchanges, making an exchange distribution of nearly 48,500 volumes.

The bibliography of North American geology for 1906 and 1907, consisting of 2,672 titles and a comprehensive index, was compiled during the year and published as Bulletin 372. The bibliography for 1908 (Bulletin 409) is well advanced.

The correspondence, which refers largely to the exchange and the purchase of books, consisted of 3,300 letters received and 3,835 letters sent. Ninety-four letters and other papers were translated by members of the library force for other branches of the Survey.

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

THIRTY-FIRST ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR
ENDED JUNE 30

1910

WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

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THIRTY-FIRST ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

GEORGE OTIS SMITH, *Director.*

The appropriations for the work of the United States Geological Survey for the fiscal year 1909–10 comprised items amounting to $1,497,815. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

SPECIAL FEATURES OF THE WORK.

PROGRESS IN LAND CLASSIFICATION.

OUTLINE OF WORK.

The work of the land-classification board is for the most part based on field investigations made by other sections, divisions, and branches of the Survey, as well as by the General Land Office. The land-classification work during the year has included—

1. The preparation of withdrawals covering power sites and coal, oil, gas, and phosphate lands.
2. The classification and restoration of withdrawn lands and the classification of certain mineral claims in national forests.
3. The designation of lands under the enlarged-homestead act and the consideration of petitions for such designation.
4. The consideration of applications for the reclassification of lands classified as coal land and of referred reports of special agents of the General Land Office with respect to the mineral character of classified, withdrawn, and other lands.
5. Reports to the Secretary, Land Office, and Indian Office regarding the possibility of developing power on lands involved in applications under the right-of-way acts and regarding the feasibility of proposed irrigation enterprises under the Carey Act.

PHOSPHATE LANDS.

Withdrawals of public phosphate lands have been made in aid of proposed legislation, for the reason that many conflicting claims have arisen through efforts to locate and acquire title to such lands under existing laws and for the further reason that the maintenance of the agricultural wealth of the country requires that the exportation of these supplies of valuable plant food be prevented by some effective method.

The field examination of these withdrawn lands is being energetically pushed, so that all lands which are in fact not underlain by phosphate deposits may be promptly released from these withdrawals and new phosphate territory may be included. During the fiscal year areas aggregating 2,322,416 acres, which had been included in phosphate withdrawals, have been restored to entry as the result of field work showing that they are not valuable for phosphate, and 401,954 acres of new phosphate territory found by these examinations have been included in the withdrawals. The withdrawals by States are tabulated elsewhere (p. 47).

POWER SITES.

The policy of withdrawing lands in aid of proposed legislation affecting the use and disposition of water-power sites was actively continued during the year at the rate of about 100,000 acres a month, the total withdrawals for the year amounting to 1,219,818 acres. As a result of field work showing the lands not to be valuable for power 45,189 acres were released from existing withdrawals and restored to the public domain. The areas covered by withdrawals in the several States, as well as the total area covered by outstanding withdrawals on July 1, 1910, are given in the table on page 48.

COAL LANDS.

The energies of the coal-land classification board have been directed toward the completion and systematization of the records of past investigations and actions; the classification and appraisement of the large areas which had been examined in previous years but on which no classification had been reported; the reclassification, under the new regulations of April 10, 1909, of all areas previously classified; and the withdrawal of areas which by these former examinations were indicated to contain valuable deposits of coal but with regard to which the information at hand was not sufficient for a complete classification and appraisement.

Classifications and valuations.—The board has during the year classified and appraised, with respect to coal value, 14,512,932 acres which had not previously been classified, of which 587,306 acres were required to offset the amount lost by rewithdrawals where new data indicated the existing classifications to be erroneous. It has reclassified 4,206,528 acres covered by former classifications. These, with the areas restored without appraisal because they are private lands, or without classification because of their doubtful value as to coal, amounting to 2,602,215 acres, make a total of 21,321,675 acres acted on during the year. The total value of the 5,618,769 acres appraised as coal land during the year, at the minimum price fixed by law, is $87,816,599; the value fixed by the board is $380,955,646, an increase of approximately $300,000,000. The total area on June 30, 1910, covered with classification and appraisement as coal land, under both the old and the new regulations, is 10,031,390 acres, and the total appraised value of those lands is $449,876,208. The progress of coal-land classifications and the net areas covered by existing classifications under the old and new regulations on July 1, 1909, and July 1, 1910, exclusive of restorations without classification and of classifications as coal land without appraisement, are shown in the table on page 45.

Withdrawals.—The coal-land withdrawals have been extended during the year to cover the principal remaining areas of the extensive coal fields in eastern Montana and Wyoming, only portions of which had been previously withdrawn. These withdrawals, together with those covering newly discovered coal fields in Utah and Arizona and the rewithdrawal of 587,306 acres where new data indicated the existing classifications to be erroneous, make a total withdrawal for the year of 20,425,728 acres.

Recommendations for withdrawal covering the very extensive area of low-grade coal lands in North Dakota and South Dakota were prepared during the fiscal year, but the withdrawals were not made until the early part of July, 1910. Although these lands had been known for many years to contain coal, inclusive withdrawals had not been made for the reason that the agricultural value of the land was almost everywhere greater than the coal value, and the value of the coal was not deemed sufficient to warrant the great retardation of development which would follow withdrawal. With the passage of the law making it possible to obtain patent to the surface of coal lands under the agricultural-land laws, this objection to withdrawal no longer existed. It is believed that with these new withdrawals in Montana, Wyoming, Utah, Arizona, North Dakota, and South Dakota only small areas of public lands will be found to contain coal in amounts which will make additional withdrawals necessary, except in coal fields in existing Indian reservations.

The outstanding withdrawals on July 1, 1909, and July 1, 1910, together with a summary statement of new withdrawals and actions which have tended to reduce existing withdrawals, are given by States in the table on page 46.

OIL LANDS.

At the beginning of the fiscal year oil-land withdrawals from agricultural entry included 2,270,144 acres in California and 173,530 acres in Wyoming, and oil-land withdrawals from all acquisition covered 1,451,520 acres in Louisiana (of which only 6,599 acres are known to be vacant unappropriated land) and 74,849 acres in Oregon.

On September 26, 1909, the President decided that all public oil lands should be withheld from all disposition pending Congressional action, for the reason that the existing mineral-land law is not well adapted to deposits of this character and for the further reason that it seemed desirable to reserve certain fuel-oil deposits for the use of the American navy. Accordingly, the form of all existing withdrawals was changed, and new withdrawals aggregating 2,749,260 acres were made in Arizona, California, Colorado, New Mexico, Utah, and Wyoming. Field examinations passed on by the oil-land classification board during the year resulted in the restoration of 2,172,182 acres of land which were found not to be valuable for oil. The aggregate areas in the several States covered by withdrawals outstanding July 1, 1909, and July 1, 1910, are presented in the table on page 47, together with a summary statement of the restorations of lands found not to be valuable for oil.

GEOLOGIC INVESTIGATIONS.

Geologic surveys and investigations were continued during the year in 32 States and Territories, and over 66 per cent of the appropriation for geologic surveys was expended in the 16 public-land States and Territories. In connection with the land-classification work, about 15,300 square miles of supposed coal territory in the Rocky Mountain region were examined. Other work in the public-land States included continuation of the study of the phosphate deposits in Idaho, Wyoming, and Utah and systematic, detailed surveys of important mining districts in Washington, Colorado, Utah, Nevada, California, Idaho, Arizona, and Missouri and of oil fields in southern California and Oklahoma.

Under instructions of the Secretary of the Interior, C. A. Fisher was detailed to examine for the General Land Office the group of coal claims in Alaska under investigation by that bureau and spent about two months and a half in this work.

HISTORY OF TECHNOLOGIC INVESTIGATIONS.

The organization of the Bureau of Mines July 1, 1910, makes this report of the Geological Survey an appropriate place to review the work now transferred to that bureau.

AUTHORITY.

The Survey's investigation of fuels had its beginning in the appropriation act of February 18, 1904, carrying $30,000 "for analyzing and testing at the Louisiana Purchase Exposition the coals and lignites of the United States, * * * under the supervision of the Director of the United States Geological Survey." This was followed by other appropriations—$30,000 April 27, 1904; $25,000 January 5, 1905; $202,000 March 3, 1905; $250,000 for each of the fiscal years 1906, 1907, 1908, and 1909; and $100,000 for the fiscal year 1910.

The investigation of structural materials under the Geological Survey was authorized under the sundry civil appropriation act of March 3, 1905, carrying $7,500 for this purpose, and the deficiency appropriation act of the same date, carrying $5,000. The work was enlarged and continued by appropriations of $100,000 for each of the fiscal years 1907, 1908, 1909, and 1910.

The investigations as to the causes of mine explosions, with a view to increasing safety in mining, were first authorized in the legislative appropriation act of May 22, 1908, carrying for this purpose an appropriation of $150,000. This was followed by a similar appropriation in the act providing for the sundry civil expenses of the Government for 1910. A fully equipped mine experiment station was established in Pittsburg during 1908, at which investigations of explosives, coal gas, dust, electricity, and other possible causes of mine explosions have since been continually under way.

Through the courtesy and cooperation of the Louisiana Purchase Exposition and the city of St. Louis, the investigations of fuels and structural materials were continued on the exposition grounds during 1905 and 1906 and those of structural materials until 1909. During 1907 the fuel investigations were transferred to Norfolk, Va., and early in 1908 to Pittsburg, where a large part of the work on structural materials also is now done. In April, 1907, these two series of investigations were, by order of the Secretary of the Interior, included in an administrative unit—the technologic branch of the Geological Survey.

The act establishing the Bureau of Mines, approved May 16, 1910, as amended in the sundry civil appropriation act approved June 25, 1910, transfers to that bureau the investigations, personnel, and equipment of the fuels and mine-accidents divisions of the technologic branch of the Geological Survey, to take effect July 1 of this year. The sundry civil act also provides that the structural-materials investigations heretofore carried on by the Geological Survey shall be continued by the Bureau of Standards.

INVESTIGATION OF MINE ACCIDENTS.

The study of mine explosions and their causes at the Pittsburg station has been developed under five phases, as follows:

1. Investigations in the mines to determine the conditions leading up to mine explosions and means of preventing them.

2. Investigations of explosives used in coal mines, to determine those that can be used with least risk in mines where gas or inflammable dust may be found.

3. Investigations of the conditions under which electric equipment can be safely used in coal-mining operations where there is risk of explosions.

4. Investigations of mine lamps as possible causes of mine explosions, and of the relative safety and efficiency of mine lamps of different types.

5. Investigations of the various types of artificial breathing apparatus suited for use in the study of mine disasters.

The mining engineering field force of the Geological Survey has already made decided progress in the study of underground mining conditions and methods. Practically all the coal mines in which explosions have occurred during the last two years have been carefully examined; the gases, coal dust, coke, etc., have been analyzed at the Pittsburg laboratory; and every effort has been made to determine the explosibility of various mixtures of gas and air in the presence of shots of explosives of different types. Investigations have been made as to the explosibility of dust from various typical coals under similar conditions, the chemical composition and physical characteristics of this dust and of the coal from which it is formed, and the methods of preventing dust explosions by wetting the dust by sprinkling or other methods.

Considerable progress has been made also in the investigation of explosives used in coal mining and the determination of the conditions under which they may be used with least risk, especially where either gas or inflammable coal dust is present in quantities that indicate danger. In arranging for this work, the manufacturers of explosives were invited to submit for test, according to a published program, such of their explosives as they had reason to believe might meet the conditions prescribed. In response to this invitation a number of explosives have been submitted for investigation, and a considerable portion of them have passed the required tests and have therefore been classed among the "permissible explosives." Three lists of such explosives have been published, the latest (May, 1910) containing a total of 45 permissible explosives.

The investigations in connection with electricity as one of the possible causes of coal-mine explosions have related mainly to inclosed electric fuses, as to whether, in actual use, they may or may not ignite an explosive mixture of air and gas or inflammable dust; to the development of electric methods of determining automatically the percentage of gas present in air in different parts of the mine and indicating it in the superintendent's office; to the relative safety and permanence of different types of insulation of electric wires under mine conditions;

and to the conditions under which closed electric motors may be safely used in gaseous or dusty mines.

The investigations and educational work in connection with the use of artificial breathing apparatus and other types of mine rescue equipment have been useful in developing better methods for using such equipment both in the examination of mines in which explosions have occurred and in mine rescue work. As an outgrowth of the work already done four branch mine rescue experiment stations have already been established and nine others have been authorized by Congress; and three fire-fighting and mine rescue stations have been authorized by the general assembly of Illinois and will be established during the next few months. In addition, many mining companies have purchased mine rescue equipment for establishing local stations of their own in all the more important coal fields.

FUEL TESTING.

The work of the fuel division during the current fiscal year, owing to the reduction in its appropriation from $250,000 to $100,000, has been confined largely to the routine testing of coal and other mineral fuels needed for use by the Government. This phase of the work has developed to such an extent that nearly all the fuel now purchased by the Government is either purchased on specifications and subject to tests by the fuel division or purchased after examinations of the coal supplied by the mines from which coal is delivered to the Government.

In addition to this routine testing work, certain investigations have been conducted during the year to promote increased efficiency in the use of fuel by the Government; also general investigations concerning the processes of combustion, the organic composition of coal, the causes of and methods of preventing spontaneous combustion, and other allied subjects that are considered to have a special bearing on the government work.

The investigations begun at St. Louis and continued at Norfolk in connection with the testing of coal under boilers and in gas producers have been, for the most part, necessarily discontinued, and final reports on these subjects are nearly ready for publication.

Investigations as to the adaptability of different grades of coal for briquetting are now limited largely to laboratory investigations of binding materials and experiments in briquetting lignites and lignitic coals from the public-land States.

The chemical laboratories associated with this division have not only made the routine analyses of coals purchased by the Government but have also analyzed many samples of coal collected by the geologists of the Survey in connection with the classification of the public lands.

The investigations into the waste in the mining and utilization of coal have brought out important information as to the nature and extent of this waste and have proved useful in awakening the public to the need of improving the conditions to which it is now largely due. During the last two years much attention has also been given to the problem of a more extensive and less wasteful use of other mineral fuels, especially natural gas, fuel oil, and oil products.

The fuel investigations have also included an inquiry into the possibility of substituting peat for mineral fuels in regions where the latter are scarce and expensive.

INVESTIGATION OF STRUCTURAL MATERIALS.

The investigation of structural materials begun at St. Louis in 1905 was a continuation of and followed logically from the investigations of cement-making materials, building stone, and clays which had been carried on to some extent by the Geological Survey for several years.

Tests of cement were made at St. Louis during the Louisiana Purchase Exposition under the auspices of the Association of American Portland Cement Manufacturers, who had prepared for the exposition a cement pavilion with three rooms, in the largest of which was a working exhibit of cement and concrete testing machinery. At the close of the exposition this pavilion and other necessary buildings were placed at the disposal of the Government for use in the structural-materials investigations then proposed. The enlargement of the work in 1906 made necessary the acquirement of additional buildings for the housing of the laboratories, and the exposition authorities granted for this work the free use of the foundry exhibit building (100 by 125 feet) and metal pavilion (100 by 60 feet floor space). Owing to the necessity of removing these buildings from the exposition grounds, which were retransferred to the city of St. Louis as a part of the public park, and the inability of the Survey to obtain quarters for the work elsewhere in St. Louis, the structural-materials investigations were transferred to the government buildings available for them on the arsenal tract in Pittsburg.

Although the purpose of these investigations has been primarily to meet the Government's own needs, incidentally the results are published in such a manner as to make them of value to the engineering profession and to the general public. Moreover, these investigations were so planned as to make use of and to correlate all similar work by others, in state testing laboratories, in the testing laboratories of universities, and through the agencies of engineering societies and their joint committees.

The investigations conducted during the year include inquiries into the nature, extent, and distribution of materials needed for the use of the Government in its building and construction work. They were planned after a careful consideration of the statements of needs submitted by the Supervising Architect, the Isthmian Canal Commission, and other branches of the government service having such work in charge. They have related primarily to concrete, reenforced concrete, and other cement products and their constituent materials, clay products, stone, and miscellaneous materials, and the behavior of such structural materials under the action of fire, water, acids, alkalies, and other destructive agencies.

DISTRIBUTION OF PUBLICATIONS.

The increase in the volume of distribution of reports and maps is more than keeping pace with the growth of the Survey. The number of letters received relating to publications and the amount of money received from sales of publications furnish, perhaps, the best index of the relation of the Survey to the public. The increase for 1910 over 1909 in such letters received was more than 20 per cent, and the money receipts show a gain of more than 6 per cent. The total number of reports and maps distributed has increased more than 13 per cent. These figures may be compared with the growth in the total correspondence of the Survey, the number of pieces of incoming mail handled during the year showing an increase of not quite 9 per cent over the number in the fiscal year 1909.

WORK OF THE YEAR.

PUBLICATIONS.

The Survey's work finds public expression chiefly through its reports and maps. The publications of the last fiscal year are briefly described in the following summaries:

Thirtieth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1909. 128 pp., 2 pls.

A report on special features of the Survey's work, brief abstracts of publications of the year, and a summary of the work by branches and divisions, with maps showing the progress of topographic and geologic surveys.

Professional Paper 64. The Yakutat Bay region, Alaska (Physiography and glacial geology by Ralph S. Tarr; Areal geology by Ralph S. Tarr and Bert S. Butler). 183 pp., 37 pls., 10 text figures.

An elaborate description of the region, especially of its glacial history, with chapters on early exploration, the distribution of plants and animals, and the mineral resources.

Professional Paper 65. Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming, by N. H. Darton. 105 pp., 24 pls., 15 text figures.

Describes the geology of the sedimentary rocks—their stratigraphy, structure, and geologic history—and discusses the mineral resources of the region, including underground water, coal, gypsum, and other minerals. Also contains information respecting surface waters available for irrigation and stock raising and notes on timber and climate. The illustrations comprise geologic and topographic maps, a map showing the distribution of underground waters, sections showing stratigraphy, and half-tone reproductions of photographs.

Professional Paper 66. The geology and ore deposits of Goldfield, Nev., by Frederick Leslie Ransome, assisted in the field by W. H. Emmons and G. H. Garrey. 258 pp., 35 pls., 34 text figures.

A description of the geology, geologic history, mineralogy, ore deposits, and mines of the district; with a history of mining and a list of previous reports. Contains also notes on ore treatment and an account of the origin of the mineral deposits. The illustrations include geologic maps and sections, mine plans and sections, half-tone views, and photomicrographs of ores and rocks.

Professional Paper 67. Landslides in the San Juan Mountains, Colorado, including a consideration of their causes and their classification, by Ernest Howe. 58 pp., 20 pls., 4 text figures.

A detailed description of the landslides and rock streams, a brief summary of the various views entertained concerning landslides in general, and a discussion of their nature and causes.

Bulletin 360. Pre-Cambrian geology of North America, by Charles Richard Van Hise and Charles Kenneth Leith. 939 pp., 2 pls.

A full account of the present state of knowledge of the pre-Cambrian rocks of North America, including a general description of the rocks, summaries of the literature on the several regions considered, statements of the established conclusions, and correlations of formations in the several regions. The accompanying maps show pre-Cambrian areas of North America and of the Lake Superior region.

Bulletin 377. The fauna of the Caney shale of Oklahoma, by George H. Girty. 106 pp., 13 pls.

Descriptions of species, a register of localities where the fossils were found, and half-tone figures of specimens. Includes suggestions as to age and correlations.

Bulletin 380. Contributions to economic geology, 1908: Part I, Metals and nonmetals, except fuels; C. W. Hayes and Waldemar Lindgren, geologists in charge. 406 pp., 2 pls., 32 text figures.

Introductory papers by Messrs. Hayes and Lindgren summarize the publications and field work of the year bearing on deposits of metalliferous ores and on nonmetallic mineral resources except fuels. The body of the volume comprises the following papers:

Notes on the economic geology of southeastern Gunnison County, Colo., by J. M. Hill.

The Hornsilver district, Nevada, by F. L. Ransome.

Round Mountain, Nevada, by F. L. Ransome.

Mineral resources of the Grants Pass quadrangle and bordering districts, Oregon, by J. S. Diller and G. F. Kay.

Notes on the Bohemia mining district, Oregon, by D. F. MacDonald.

Faulting and vein structure in the Cracker Creek gold district, Baker County, Oreg., by J. T. Pardee.

The Yerington copper district, Nevada, by F. L. Ransome.

The Tres Hermanas mining district, New Mexico, by Waldemar Lindgren.

Tin, tungsten, and tantalum deposits of South Dakota, by Frank L. Hess.

Note on a wolframite deposit in the Whetstone Mountains, Arizona, by Frank L. Hess.

Tonnage estimates of Clinton iron ore in the Chattanooga region of Tennessee, Georgia, and Alabama, by E. F. Burchard.

The Taylor Peak and Whitepine iron-ore deposits, Colorado, by E. C. Harder.

The Hanover iron-ore deposits, New Mexico, by Sidney Paige.

The iron ores of the Appalachian region in Virginia, by E. C. Harder.

Manganese deposits of the United States, by E. C. Harder.

An occurrence of asphaltite in northeastern Nevada, by Robert Anderson.

Grahamite deposits of southeastern Oklahoma, by J. A. Taff.

Marble prospects in the Chiricahua Mountains, Arizona, by Sidney Paige.

The Niobrara limestone of northern Colorado considered as a possible source of Portland cement material, by G. C. Martin.

Cement material near Havre, Mont., by L. J. Pepperberg.

Ganister in Blair County, Pa., by Charles Butts.

Notes on the clays of Florida, by George C. Matson.

Sodium sulphate in Soda Lake, Carriso Plain, San Luis Obispo County, Cal., by Ralph Arnold and H. R. Johnson.

Sulphur deposits near Thermopolis, Wyo., by E. G. Woodruff.

Mica deposits of South Dakota, by D. B. Sterrett.

Lists of Survey publications on deposits of metals and nonmetals, except fuels.

Bulletin 382. The effect of oxygen in coal, by David White. 74 pp., 3 pls.

A report on the results of a comparative study of ultimate coal analyses made and published by the United States Geological Survey, showing that oxygen in coal is economically almost as undesirable as ash.

Bulletin 383. Notes on explosive mine gases and dusts, with special reference to explosions in the Monongah, Darr, and Naomi coal mines, by Rollin Thomas Chamberlin. 67 pp., 1 text figure.

A report on the conditions in the mines after the explosions, with analyses of gases, studies of coal dusts, and suggestions as to methods of preventing dust explosions.

Bulletin 384. A geological reconnaissance in northern Idaho and northwestern Montana, by F. C. Calkins, with notes on the economic geology, by D. F. MacDonald. 112 pp., 2 pls., 3 text figures.

A sketch of the geography and the areal and economic geology of the region, with detailed descriptions of certain localities and a geologic sketch map.

Bulletin 385. Briquetting tests at the United States fuel-testing plant, Norfolk, Va., 1907-8, by Charles L. Wright. 41 pp., 9 pls.

A description of the briquetting plant and of the results of tests of briquets made from several kinds of coal with different binders.

Bulletin 386. Pleistocene geology of the Leadville quadrangle, Colorado, by Stephen R. Capps, jr. 99 pp., 8 pls., 18 text figures.

A general consideration of ice action in the quadrangle, followed by a special consideration of glacial deposits and action in particular areas.

Bulletin 387. Structural materials in parts of Oregon and Washington, by N. H. Darton. 33 pp., 9 pls., 1 text figure.

An account of deposits of gravel, sand, clay, building stone, limestone, plaster, and cement materials in the regions about Portland, Oreg., and Takoma and Seattle, Wash., with maps showing location of the deposits and other illustrations.

Bulletin 388. The colloid matter of clay and its measurement, by Harrison Everett Ashley, with a preface by A. V. Bleininger. 65 pp., 1 pl., 9 text figures.

A report on a series of experiments and tests designed to afford a means of determining the plasticity of clays and the purposes to which they are best adapted.

Bulletin 389. The Manzano group of the Rio Grande valley, New Mexico, by Willis T. Lee and George H. Girty. 141 pp., 12 pls., 9 text figures.

Description of the stratigraphy of the group, by Mr. Lee, and of the fossils, by Mr. Girty.

Bulletin 390. Geology of the Lewistown coal field, Montana, by W. R. Calvert. 83 pp., 5 pls., 1 text figure.

Description of the geography, stratigraphy, and structure of the field and of the coal beds as exposed or developed at many places.

Bulletin 391. The Devonian fauna of the Ouray limestone, by E. M. Kindle. 60 pp., 10 pls.

Descriptions and figures of the fossils, with observations on the Devonian and Carboniferous divisions and fossils of the formation.

Bulletin 392. Commercial deductions from comparisons of gasoline and alcohol tests on internal-combustion engines, by Robert M. Strong. 38 pp.

Discusses differences in engines, effect of quality of fuel and of principal operating conditions, limit of rate of fuel consumption and other factors, and presents a summary of the conclusions reached.

Bulletin 393. Incidental problems in gas-producer tests, by R. H. Fernald, C. D. Smith, J. K. Clement, and H. A. Grine. 29 pp, 8 text figures.

A discussion of factors affecting the proper length of tests and differences of temperature in the fuel bed.

Bulletin 394. Papers on the conservation of mineral resources. 1909. 214 pp., 12 pls., 2 text figures. Reprinted from report of the National Conservation Commission, February, 1909.

Coal fields, by M. R. Campbell and E. W. Parker; Future coal production, by Henry Gannett; Petroleum, Natural gas, by D. T. Day; Peat, by C. A. Davis; Iron ores, by C. W. Hayes; Gold, silver, copper, lead, and zinc, by Waldemar Lindgren; Phosphate deposits, by F. B. Van Horn; Mineral resources of Alaska, by A. H. Brooks. The illustrations include maps of the United States showing coal, petroleum, and natural-gas fields, a map of Alaska showing known mineral deposits, and several diagrams showing rate and amount of mineral production.

Bulletin 395. Radioactivity of the thermal waters of Yellowstone National Park, by Herman Schlundt and R. B. Moore. 35 pp., 4 pls., 7 text figures.

A description of apparatus and methods used to determine the radioactivity of the waters and a statement and discussion of the results of the experiments.

Bulletin 396. Paleontology of the Coalinga district, California, by Ralph Arnold. 173 pp., 30 pls.

Descriptions of the geologic formations and of their contained fossils, with figures of the fossils.

Bulletin 397. Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Arizona, by F. C. Schrader. 226 pp., 16 pls., 37 text figures.

A general account of the geography, physiography, and geology of the region and a detailed description of the mineral deposits seen at numerous mines. The illustrations include a geologic reconnaissance map, plans and sections of claims and mines, and half-tone views.

Bulletin 398. Geology and oil resources of the Coalinga district, California, by Ralph Arnold and Robert Anderson; with report on oils, by I. C. Allen. 354 pp., 52 pls., 9 text figures.

A discussion of the geography, topography, and geology of the district and a detailed account of the territory from which oil has been obtained, notes on the occurrence and origin of the oil, and description of individual wells, together with conclusions respecting the future development of the field, tables showing areas classified as mineral land, production and estimated supply, and oil companies and wells in the district, and a chapter on character of the oil. The illustrations embrace geologic maps and sections and figures showing fossils.

Bulletin 399. Results of spirit leveling in West Virginia, 1896–1908; compiled by S. S. Gannett and D. H. Baldwin. 81 pp.

A detailed account of precise and primary leveling, showing the altitudes above sea level of more than 1,200 points.

Bulletin 400. Iron ores, fuels, and fluxes of the Birmingham district, Alabama, by E. F. Burchard and Charles Butts; with chapters on the origin of the ores, by E. C. Eckel. 204 pp., 17 pls., 19 text figures.

A description of the general geology of the district and of the Clinton and brown ores, detailed descriptions of the mines and deposits, discussions of the origin of the ores, notes on methods of mining, and an account of the fuel and fluxes used. The illustrations include economic and geologic maps of the district and many plans, sections, and half-tone views.

Bulletin 401. Relations between local magnetic disturbances and the genesis of petroleum, by G. F. Becker. 24 pp, 1 pl.

Presents the various arguments as to the mode of origin of deposits of petroleum and other hydrocarbons and suggests that some such deposits may have originated from iron or other metallic carbides formed by the action of volcanic emanations or waters. The accompanying map, showing irregularities of compass declination in the United States, indicates that petroleum deposits are intimately associated with magnetic disturbances like those arising from the presence of minerals possessing magnetic attraction.

Bulletin 402. The utilization of fuel in locomotive practice, by W. F. M. Goss. 28 pp., 8 text figures.

A report on tests made at the locomotive-testing laboratory of Purdue University, at Lafayette, Ind., with a view of obtaining greater economy and efficiency of service.

Bulletin 403. Comparative tests of run-of-mine and briquetted coals on the torpedo boat *Biddle*, by W. T. Ray and Henry Kreisinger. 49 pp., 10 text figures.

Report on tests made to determine the relative efficiency of briquets and raw coal as fuel on United States torpedo boats.

Bulletin 404. The granites of Vermont, by T. Nelson Dale. 138 pp. 5 pls., 25 text figures.

Scientific and economic discussions of the granites, with detailed accounts of the granite quarries. The report contains a bibliography of the economic geology of granite and is illustrated by maps, diagrams, and half-tone plates.

Bulletin 405. Mercury minerals from Terlingua, Tex., by W. F. Hillebrand and W. T. Schaller. 174 pp., 6 pls., 44 text figures.

A report on the occurrence and associations of the minerals and descriptions of their crystallography, with numerous figures showing forms of crystals.

Bulletin 406. Preliminary report on the McKittrick-Sunset oil region, California, by Ralph Arnold and H. R. Johnson. 225 pp., 5 pls., 2 text figures.

An account of the geography, topography, and geology of the region, the water supply, and the oil fields. Includes lists of areas classified as oil lands and areas withdrawn, a list of oil companies, and tables showing the production of oil by years. The illustrations include geologic maps of the region, showing the structure.

Bulletin 407. Geology and ore deposits of the Bullfrog district, Nevada, by F. L. Ransome, W. H. Emmons, and G. H. Garrey. 130 pp., 14 pls., 20 text figures.

Descriptions of the general and economic geology of the district, with geologic maps and sections, plans of mines, diagrams showing structure, and many half-tone views.

Bulletin 408. Reconnaissance of some mining camps in Elko, Lander, and Eureka counties, Nev., by W. H. Emmons. 130 pp., 5 pls., 22 text figures.

A report on the geology, mines, and mineral deposits of the district, with numerous maps and diagrams.

Bulletin 409. Bibliography of North American geology for 1908, by J. M. Nickles. 148 pp.

A list of papers published in 1908 on North American geology, arranged alphabetically by names of authors, an index of subjects or materials, and lists showing chemical analyses reported and minerals, rocks, and formations described.

Bulletin 410. The Innoko gold-placer district, Alaska, with accounts of the central Kuskokwim Valley and the Ruby Creek and Gold Hill placers, by A. G. Maddren. 87 pp., 5 pls.

An account of the geography, history, and other features of the district, including routes of travel, a sketch of the geology, and a report on the mineral resources. The illustrations include geologic and topographic maps.

Bulletin 411. Results of spirit leveling in Ohio, 1898–1908, compiled by S. S. Gannett and D. H. Baldwin. 147 pp.

A report on precise and primary leveling in the State, including statements of the altitude above sea level of more than 1,300 places.

Bulletin 412. Tests of run-of-mine and briquetted coal in a locomotive boiler, by W. T. Ray and Henry Kreisinger. 32 pp., 9 text figures.

A description of the fuels, apparatus, and methods employed, and a statement of the results of the tests.

Bulletin 413. A reconnaissance of the gypsum deposits of California, by F. L. Hess; with a note on errors in the chemical analysis of gypsum, by George Steiger. 37 pp., 4 pls., 2 text figures.

A description of the deposits in detail, with maps, sections, and half-tone views.

Bulletin 414. Notes on some mining districts in Humboldt County, Nev., by F. L. Ransome. 75 pp., 1 pl., 7 text figures.

Descriptions of the geology and mineral deposits of the Seven Troughs, Rosebud, and Red Butte mining districts and the Humboldt, Pahute, and Sonoma ranges, and an account of the mineralogy of the ore deposits.

Bulletin 415. Coal fields of northwestern Colorado and northeastern Utah, by H. S. Gale. 265 pp., 22 pls., 8 text figures.

An account of the geography and geology of the region and detailed descriptions of the Grand Hogback, Danforth Hills, lower White River, Vernal, western Yampa, and Henrys Fork coal fields, with a chapter on the quality of the coals. The illustrations include topographic and geologic maps, structure sections, and half-tone views.

Bulletin 416. Recent development of the producer-gas power plant in the United States, by R. H. Fernald. 82 pp., 2 pls., 3 text figures.

A report on producer-gas tests made by the Geological Survey and an account of the present status of the producer-gas power plant, with opinions of the operators of plants, summaries and particulars concerning plants visited, and a list of installations in the United States.

Bulletin 417. Mineral resources of the Nabesna-White River district, Alaska, by F. H. Moffit and Adolph Knopf; with a section on the Quaternary, by S. R. Capps. 64 pp., 5 pls., 3 text figures.

An account of the geography, geology, and mineral resources of the district, with topographic and geologic maps and half-tone views.

Bulletin 418. The fire tax and waste of structural materials in the United States, by H. M. Wilson and J. L. Cochrane. 30 pp.

An account of the methods adopted to collect statistics, statements of the results of the inquiries made, and comparisons of the fire waste in the cities of the United States with that in cities in Europe, with suggestions as to methods of reducing fire losses.

Bulletin 419. Analyses of rocks and minerals from the laboratory of the United States Geological Survey, 1880–1908, by F. W. Clarke. 323 pp.

A report of chemical analyses of rocks, clays, and soils, arranged by States, and of meteorites and minerals.

Bulletin 420. Economic geology of the feldspar deposits of the United States, by E. S. Bastin. 85 pp., 8 pls.

Descriptions of the chemical and physical characters of feldspars, of their origin and geologic occurrence, methods of mining and milling, uses, grades, prices, and production, and an account of deposits of feldspar by States. The illustrations include maps and half-tone views.

Bulletin 421. Results of spirit leveling in Illinois, 1896–1908, compiled by S. S. Gannett and D. H. Baldwin. 74 pp.

A report on precise and primary leveling, giving altitudes of more than 400 places in the State.

Bulletin 422. The analysis of silicate and carbonate rocks (a revision of Bulletin 305), by W. F. Hillebrand. 239 pp., 27 text figures.

A detailed description of the various methods of analysis, with diagrams showing the apparatus employed.

Bulletin 423. A primer on explosives for coal miners, by C. E. Munroe and Clarence Hall. 61 pp., 9 pls., 12 text figures.

A discussion of combustion and explosion, of various explosives, squibs, fuses, and detonators, of methods of mining coal with explosives, loading and firing charges, and of means of safe shipment and storage of explosives, with illustrations showing materials and methods.

Bulletin 424. The valuation of public coal lands: The value of coal land, by G. H. Ashley; Depth and minimum thickness of beds as limiting factors in valuation, by C. A. Fisher. 75 pp.

A statement of the laws relating to coal lands and the areas of coal lands classified, with discussion of the royalty value of coal land, factors affecting the sale price of the land, consideration of its market value, statement of the basis of the government valuation of coal lands, and a discussion of maximum depth of coal mining and minimum thickness of minable beds.

Bulletin 428. The purchase of coal by the Government under specifications, with analyses of coal delivered for the fiscal year 1908–9, by G. S. Pope. 80 pp.

A report setting forth the factors affecting the value of coal as a fuel and a statement of the Government's plan of purchasing coal under specifications, with descriptions of methods of sampling and testing, form of specifications, and tables showing the extent of the Government's use of coal.

Water-Supply Paper 227. Geology and underground waters of South Dakota, by N. H. Darton. 156 pp., 15 pls., 7 text figures.

A detailed description of the stratigraphy of the Black Hills region and summary accounts of the geology of other parts of the State, a brief description of the water horizons, and descriptions by counties of deep wells and well prospects, with a chapter on the construction and management of artesian wells. The illustrations include a geologic map, a map showing artesian conditions, other maps, diagrams, and half-tone views.

Water-Supply Paper 232. Underground water resources of Connecticut, by Herbert E. Gregory, with a study of the occurrence of water in crystalline rocks, by E. E. Ellis. 200 pp., 5 pls., 31 text figures.

A description of the geography, geology, and ground waters and of the character of the water, with chapters on well construction and springs. Contains maps showing distribution of chlorine, other maps, and diagrams and half-tone views.

Water-Supply Paper 233. Water resources of the Blue Grass region, Kentucky, by George Charlton Matson, with a chapter on the quality of the waters, by Chase Palmer. 223 pp., 3 pls., 6 text figures.

Describes briefly the geology, physiography, soils, and surface waters, treats in detail the underground waters, the source of municipal supplies, and the condition in each county, and discusses the chemical content of the waters, including those of the mineral springs.

Water-Supply Paper 234. Papers on the conservation of water resources. Reprinted from report of the National Conservation Commission, February, 1909. 96 pp., 2 pls.

Papers on distribution of rainfall, by Henry Gannett; on floods and on developed and undeveloped water powers, by M. O. Leighton; on irrigation, by F. H. Newell; on underground waters, by W. C. Mendenhall; on denudation, by R. B. Dole and Herman Stabler; and on control of catchment areas, by H. N. Parker. Contains maps of the United States showing mean annual precipitation and percentages of annual precipitation received during the warmer months.

Water-Supply Paper 235. The purification of some textile and other factory wastes, by Herman Stabler and Gilbert H. Platt. 76 pp.

Studies of the pollution of streams by wastes from wool scouring, bleaching and dyeing cotton yarn, bleaching cotton piece goods, and by the manufacture of oleomargarine, fertilizer, and glue, and report on experiments for purification of the wastes.

Water-Supply Paper 236. The quality of surface waters in the United States. Part I. Analyses of waters east of the one hundredth meridian, by R. B. Dole. 123 pp.

States methods of examination, the probable accuracy of the analytical results and the mode of expressing them, and the location of the sampling stations, and presents mineral analyses of samples of water taken from many rivers.

Water-Supply Paper 238. The public utility of water powers and their governmental regulation, by René Tavernier and Marshall O. Leighton. 161 pp.

An introduction by Mr. Leighton; chapters on French and foreign legislation affecting water powers, proposed French laws, and a review of the French administrative work in hydraulics and agricultural improvements, by Mr. Tavernier; and a chapter on water-power legislation in the United States, by Mr. Leighton.

Water-Supply Paper 239. The quality of the surface waters of Illinois, by W. D. Collins. 94 pp., 3 pls.

An outline of the physical and economic features of the State and a detailed consideration of the quality of the waters, with many mineral analyses.

Water-Supply Paper 241. Surface water supply of the north Atlantic coast, 1907–8, by H. K. Barrows and R. H. Bolster. 356 pp., 6 pls.

Water-Supply Paper 242. Surface water supply of the south Atlantic coast and eastern Gulf of Mexico, 1907-8, by M. R. Hall and R. H. Bolster. 226 pp., 3 pls., 1 text figure.

Water-Supply Paper 243. Surface water supply of the Ohio River basin, 1907–8, by A. H. Horton, M. R. Hall, and R. H. Bolster. 224 pp., 4 pls., 1 text figure.

Water-Supply Paper 244. Surface water supply of the St. Lawrence River basin, 1907–8, by H. K. Barrows, A. H. Horton, and R. H. Bolster. 163 pp., 7 pls., 1 text figure.

Water-Supply Paper 245. Surface water supply of upper Mississippi and Hudson Bay basins, 1907–8, by A. H. Horton, E. F. Chandler, and R. H. Bolster. 133 pp., 5 pls., 1 text figure.

Water-Supply Paper 247. Surface water supply of lower Mississippi basin, 1907–8, by A. B. Freeman, W. A. Lamb, and R. H. Bolster. 124 pp., 2 pls., 2 text figures.

Water-Supply Paper 248. Surface water supply of western Gulf of Mexico, 1907–8, by A. B. Freeman and R. H. Bolster. 171 pp., 4 pls., 1 text figure.

Water-Supply Paper 249. Surface water supply of Colorado River basin, 1907–8, by A. B. Freeman and R. H. Bolster. 206 pp., 10 pls.

Water-Supply Paper 250. Surface water supply of the Great Basin, 1907–8, by E. C. La Rue and F. F. Henshaw. 151 pp., 6 pls., 1 text figure.

Water-Supply Paper 252. Surface water supply of Columbia River and the north Pacific coast, 1907–8, by J. C. Stevens and F. F. Henshaw. 1910. 418 pp., 9 pls.

Water-Supply Papers 241 to 252 contain the results of stream measurements in the United States during the calendar years 1907 and 1908, continuing the Survey's series of reports on stream gagings. These papers give gage-height records, results of current-meter measurements, rating tables, and estimates of monthly discharges at stations maintained on many streams.

Mineral resources of the United States, calendar year 1908. Part I. Metallic products; 816 pp., 2 pls., 3 text figures. Part II. Nonmetallic products; 899 pp., 1 pl., 6 text figures.

Statistics of production of mineral substances in the United States, including accounts of the chief features of mining progress and comparisons of past and present production and conditions. A consolidation of 48 advance chapters each reporting on a separate mining industry.

Geologic folio 167. Description and maps of the Trenton quadrangle, comprising 912 square miles in New Jersey and Pennsylvania, by F. Bascom, N. H. Darton, H. B. Kümmel, W. B. Clark, B. L. Miller, and R. D. Salisbury. Survey made in cooperation with the States of New Jersey and Pennsylvania. 24 folio pages of text (with 3 text figures), 2 maps, 1 structure-section sheet, 2 columnar sections, and a table of formations. Published also in octavo form: 185 pages of text, with 3 figures; maps in pocket.

Geologic folio 168. Description and maps of the Jamestown, Eckelson, and Tower quadrangles, comprising 2,460 square miles in South Dakota, by Daniel E. Willard. 10 folio pages of text (including 6 text figures) and 9 maps showing topography, geology, and artesian-water prospects. Published also in octavo form: 76 pages of text, with 6 figures; maps in pocket.

Geologic folio 169. Description and maps of the Watkins Glen and Catatonk quadrangles, comprising 885 square miles in New York, by Henry S. Williams, Ralph S. Tarr, and Edward M. Kindle. Survey made in cooperation with the State of New York. 33 folio pages of text (including 13 text figures), 6 maps, and 2 sheets of half-tone illustrations. Published also in octavo form: 242 pages of text, with 37 figures; maps in pocket.

Geologic folio 170. Description and maps of the Mercersburg and Chambersburg quadrangles, consisting of 458 square miles in Pennsylvania, by George W. Stose. Survey made in cooperation with the State of Pennsylvania. 19 folio pages of text (including 5 text figures), 4 maps, 2 structure-section sheets, 1 columnar section, and 1 sheet of half-tone illustrations. Published also in octavo form: 144 pages of text, 18 figures; maps in pocket.

Geologic folio 171. Description and maps of the Engineer Mountain quadrangle, comprising 236 square miles in Colorado, by Whitman Cross and Allen D. Hole. 13 folio pages of text (including index map), 1 topographic, 1 geologic, and 1 structure-section map, 1 columnar section, and 2 sheets of half-tone illustrations. Published also in octavo form: 101 pages of text, with index map; 13 plates; maps and structure and columnar sections in pocket.

Geologic folio 173. Description and maps of the Laramie and Sherman quadrangles, comprising 1,797 square miles in Wyoming, by N. H. Darton, Eliot Blackwelder, and C. E. Siebenthal. 17 folio pages of text (including 3 text figures), 2 topographic and 2 geologic maps, 2 sheets showing structure sections, 2 columnar sections, 1 map showing artesian-water prospects, and 1 sheet of half-tone illustrations. Published also in octavo form: 128 pages of text, with 3 figures; 8 plates; maps and sheets of sections in pocket.

Topographic maps as follows:

Acworth, Ga.
Alliance, Ohio.
Antietam, Md.-Va.-W. Va.
Atlanta, Tex.-Ark.-La.
Bedford, Pa.
Bellefonte, Pa.
Bloomington, Ind.
Breckenridge special, Colo.
Carbondale, Cal.
Carson Sink, Nev.
Castle, Cal.
Central City, Ky.
Clay, Cal.
Clay, W. Va.
Coharie, N. C.
Colorado Springs, Colo.
Columbiana, Ohio-Pa.
Conesville, Ohio.
Continental, Ohio.
Cooperstown, N. Y.
Cosumnes, Cal.
Defiance, Ohio.
Ducktown special, Tenn.
Earlington, Ky.
Elk Grove, Cal.
Elkins, W. Va.
Eugene, Oreg.
Fairbanks, Alaska.
Fairfield, Pa.
Fish Springs, Utah.
Florin, Cal.
Franklin, Tenn.
Gaffney, N. C.-S. C.
Gallina, N. Mex.
Garden Valley, Idaho.
Gassaway, W. Va.
Glendive, Mont.-N. Dak.
Goose Creek, Cal.
Grand Hogback, Colo.
Granville, Ohio.
Gros Ventre, Wyo.
Hartford, Ky.
Herrin, Ill.
Higdon, Mo.
Howell, Mich.
Isleton, Cal.
Jensen, Utah-Colo.
Lancaster, Ohio.
Linden, Tex.
Lisbon, Ohio.
Livermore, Colo.
Logan, Ohio.
Luther, Okla.
McAlester, Okla.
McClure, Ohio.
Madisonville, Ky.
Midkiff, W. Va.
Milford, Mich.
Milo, Iowa.
Montgomery, W. Va.
Mound, La.
Newark, Ohio.
New Boston, Tex.
Oconomowoc, Wis.
Pawhuska, Okla.
Perkins, Okla.
Pleasant Grove, Cal.
Providence, Ky.
Rangely, Colo.
Ray, Ariz.
Rockford, Minn.
Rock Springs, Wyo.
Roosevelt, Ariz.
Sapphire, Mont.
Silver City, N. Mex.
Sparta, Wis.
Stony Creek, N. Y.
Strawberry Valley, Utah.
Thornville, Ohio.
Thurston, Ohio.
Tuskahoma, Okla.
Waterloo, Wis.
Watertown, N. Y.
Wayne, W. Va.
West Frankfort, Ill.
White River, Colo.
Whitesville, Ky.
Winding Stair, Okla.
Winnepesaukee, N. H.
York, Pa.
Yosemite Park, administrative map.
Zanesville, Ohio.
Zillah, Wash.

FIELD WORK BY THE DIRECTOR.

During the year the Director visited topographic parties in California and engaged in geologic work in the high Sierra. In company with the Secretary of the Interior he visited the Yosemite Valley and other sections of the west slope of the Sierra for the study of departmental problems. He took part in field conferences with administrative officers, geologists, and engineers of the Survey and of the Reclamation and Forest services and attended the irrigation congress at Spokane, the mining congress at Goldfield, and the Minnesota conservation convention at St. Paul.

GEOLOGIC BRANCH.

ADMINISTRATION.

The geologic branch consists of four divisions—(1) geology and paleontology, C. W. Hayes in charge; (2) Alaskan mineral resources, A. H. Brooks in charge; (3) mining and mineral resources, E. W. Parker in charge; and (4) chemical and physical research, G. F. Becker in charge.

The chief geologist, C. W. Hayes, has general supervision of the work of the geologic branch, and the divisions cooperate in the several lines of work. Members of one division are employed in the work of another whenever it seems desirable, and such transfer is easily effected. The statistical reports of the division of mineral resources are for the most part prepared by geologists from the division of geology who are detailed to the work for a portion of the year.

PUBLICATIONS.

The publications of the year prepared in the geologic branch included 6 geologic folios, 4 professional papers, 29 bulletins, and the annual volume on mineral resources. Besides these a large number of papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies, and some original matter obtained incidentally during the course of the work and not appropriate for official reports has also been made the subject of unofficial publications. Such publications are ordinarily restatements of results in a more technical form, and are usually prepared by members of the Survey without compensation.

The progress of geologic mapping during the year, as represented in the publications of the Survey, is shown on Plate I.

DIVISION OF GEOLOGY AND PALEONTOLOGY.

ORGANIZATION.

The scientific force at the beginning of the year consisted of 51 geologists, 50 assistant geologists, and 29 junior geologists. During the year there were 10 resignations and 3 appointments, resulting in a net loss of 7, or a total of 123 at the end of the year. Of the total number 76 were continuously employed, 24 carried on the per diem roll gave only a portion of their time to Survey work, and 30 were not employed during the year. In addition to the regular force 35 field assistants were employed for a portion of the year.

The work of the division is organized under a number of sections, as follows:

Areal and structural geology, Arthur Keith in charge.
Paleontology and stratigraphic geology, T. W. Stanton in charge.
Economic geology, metalliferous ores, Waldemar Lindgren in charge.
Economic geology, fuels, M. R. Campbell in charge.
Land classification, A. C. Veatch in charge.

The section chiefs have direct supervision, both in the field and in the office, of the work in their sections and are directly responsible for maintaining a high scientific standard.

FIELD WORK BY THE CHIEF GEOLOGIST.

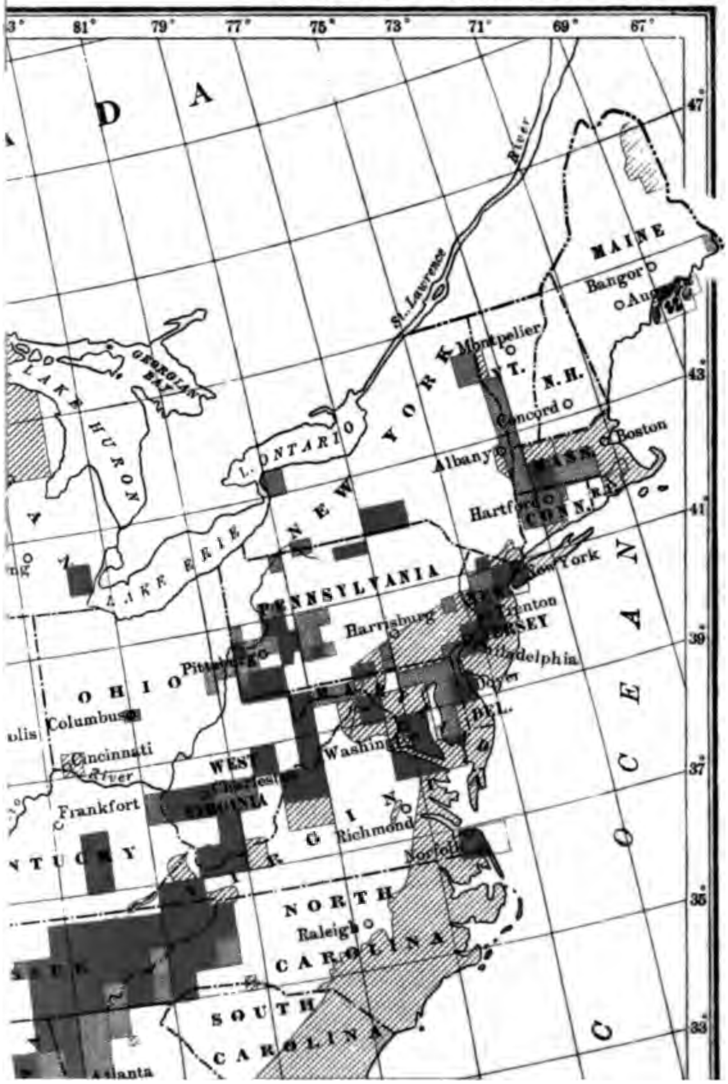
During July, 1909, the chief geologist completed an inspection of work in progress in the Oklahoma oil fields. He then visited all the producing oil fields in California in company with Ralph Arnold, who had been carrying on investigations in these fields for several years. This inspection was made for the purpose of determining where and by what methods the oil investigations could be most advantageously extended. In September he visited the parties in Utah, Idaho, and Wyoming engaged in the investigation of phosphate deposits and the classification of public lands containing these deposits. Questions of special importance in connection with the classification and valuation of these lands and the application to them of the mining law required consideration in the field with the geologists engaged in making the surveys and the section chief in charge of the work. On the completion of this inspection a party working in Oklahoma was visited and also some localities in Louisiana where oil, gas, rock salt, and sulphur had been recently discovered under conditions throwing much light on the general scientific and economic problems of oil and gas accumulation in the Gulf Coastal Plain.

The chief geologist was out of the United States for two months during the year on leave without pay.

GEOLOGIC WORK IN EASTERN AND SOUTHEASTERN STATES.

New England.—Cooperative geologic work in Maine was continued during the year, $1,200 being allotted by the State Survey and $1,300 by the Federal Survey.

The preparation of the Eastport folio (Me.) was carried nearly to completion by E. S. Bastin and C. L. Breger. It is thought that the text and maps will be submitted for publication before the close of the year 1910. In connection with the preparation of this folio a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NEW YORK
GEORGIAN BAY
LAKE HURON
LAKE ERIE
PENNSYLVANIA
Harrisburg
Pittsburg
New York
Trenton
NEW JERSEY
Philadelphia
Dover
DEL.
OHIO
Columbus
Cincinnati
River
WEST VIRGINIA
Charleston
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VIRGINIA
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special study of the Silurian faunas was made by Mr. Breger. The late Silurian formations in the Eastport region are remarkably well developed, and Mr. Breger's report is expected to be of considerable value to students of the Silurian.

The report on the fossil fauna of the Chapman sandstone of Aroostook County, Me., by H. S. Williams and C. L. Breger, was completed and submitted for publication. This report will be an important contribution to the problem of determining the boundaries between the Silurian and Devonian.

A report on the pegmatite deposits of Maine, by E. S. Bastin, was completed.

Work in the preparation of the Mount Desert folio (Me.) was continued by C. W. Brown.

A study of the ore deposits of Maine and New Hampshire was made by W. H. Emmons, and the report is now in press (Bulletin 432).

Field work for a supplemental report on the granites of New Hampshire was completed by T. N. Dale, and this report was published in Bulletin 430.

The geologic and economic survey of the Monadnock quadrangle, in southwestern New Hampshire, was well advanced by B. K. Emerson.

Considerable progress was made by T. N. Dale in the preparation of the Ticonderoga folio (Vt.-N. Y.), and Mr. Dale has completed the microscopic study of the rocks in the Brandon quadrangle (Vt.).

An extensive reconnaissance was made by Arthur Keith in the valley of western Vermont and adjoining parts of the Green Mountains to determine the sequence and structure of the Cambrian and Ordovician formations. The divisibility of the great limestone mass of the valley from Canada to Massachusetts was made clear, as well as the general existence of overthrust faults along the east side and the center of the valley.

Additional field work was done by T. N. Dale on the granites of Massachusetts, forty quarries being visited. The results of this work will be published as a supplemental note on the granites of Massachusetts.

The bulletin on the granites of Connecticut, by T. N. Dale and H. E. Gregory, was completed and has been submitted for publication.

Atlantic and Gulf coastal plains.—In cooperation with the state geological surveys the studies of the Atlantic and Gulf coastal plains were continued throughout the year. The work was carried on under the general supervision of T. W. Vaughan, who personally inspected various critical localities. W. B. Clark continued in immediate charge of the coastal-plain district extending from Massachusetts to and including North Carolina, and Mr. Vaughan had immediate charge of the remainder of the coastal-plain area.

During the year the field work for the report on the underground water resources of Delaware, Maryland, and the District of Columbia, which is being prepared in cooperation with the State Survey of Maryland, was completed by G. C. Matson, representing the Federal Survey, and E. H. Sapp, representing the Maryland Survey. The manuscript for this report is nearly finished and will soon be ready for publication.

Progress was made by W. B. Clark, assisted by A. D. Bibbins and H. P. Little, in the preparation of the folios covering the Choptank and Tolchester quadrangles of Maryland.

The report on the geology and underground waters of the coastal plain of Virginia, by W. B. Clark, B. L. Miller, E. W. Berry, and Samuel Sanford, has been completed and submitted. Special work on the formations of the Potomac group was done by A. D. Bibbins and H. P. Little.

The report on the geology and underground waters of the coastal plain of North Carolina, by W. B. Clark, L. W. Stephenson, B. L. Miller, and B. L. Johnson, has been completed and is now going through the press as a bulletin of the North Carolina Geological Survey.

Progress was made in the preparation of the report on the coastal plain of South Carolina, which is in charge of Earle Sloan, state geologist of South Carolina.

The report on the coastal plain of Georgia is well advanced. The manuscript covering the stratigraphy of the Cretaceous area has been completed by L. W. Stephenson, the discussion of the stratigraphy of the Tertiary area has been begun by Otto Veatch, and considerable progress has been made in the chapter on the underground water resources.

Work on the coastal plain of Alabama is being carried on by L. W. Stephenson and E. W. Berry. The study of the Cretaceous formations of this State was extended westward into Mississippi, where valuable geologic data were obtained.

Reports on the geology and underground water resources of northeastern Texas, by C. H. Gordon, and on the geology and underground water resources of the coastal plain of Texas east of Brazos River, by A. Deussen, have been transmitted for publication. Mr. Deussen is now engaged in the preparation of a report on the geology and underground water resources of the coastal plain of Texas between Brazos and Guadalupe rivers; in this work he is giving considerable attention to the clays and lignites of the region.

Studies of the oil and gas resources of northwestern Louisiana and eastern Texas were continued by G. D. Harris, who has given to the Survey much valuable information collected by him in the past.

During the year a detailed survey of Terrebonne Parish, La., with reference to its oil and gas resources, was made and the report is nearly completed. Mr. Harris, assisted by C. J. Maury, is at present engaged in a study of coast shells and well material of the Mississippi embayment. Owing to the nature of the coastal-plain deposits great difficulty is experienced in identifying geologic horizons, and it is expected that this study will be of considerable assistance.

In the study of the fossils, which play an important part in deciphering the stratigraphy of the Coastal Plain, valuable assistance has been rendered by W. B. Clark, B. L. Miller, E. W. Berry, and Miss Julia A. Gardner.

Northern Appalachian region.—In the coal fields of Pennsylvania the geologic work of the year has been confined mainly to the completion of the examination of a number of quadrangles in cooperation with the State. Until May 1 the work was in charge of G. H. Ashley, who resigned to become state geologist of Tennessee. Since that time it has been in charge of David White. Work has been carried on by Charles Butts, M. J. Munn, E. W. Shaw, W. C. Phalen, and E. F. Lines. In several of the quadrangles the studies have been restricted chiefly to the collection of supplementary data needed for bringing up to date the economic reports and maps.

Some revisionary work on the surficial geology of the Foxburg quadrangle (Pa.) was done by E. W. Shaw, and a bulletin on the coal, oil, and gas of that quadrangle was prepared by Mr. Shaw and M. J. Munn.

A reexamination of certain features in the Hollidaysburg quadrangle (Pa.) was made by Charles Butts, whose manuscript for the folio covering this quadrangle is nearly finished. Special studies of the stratigraphy of the coals in the Barnesboro and Patton quadrangles (Pa.) were also made by Mr. Butts in connection with sampling the coals for chemical analysis. The results will be embodied in the folio treating of the two quadrangles.

The folio covering the Burgettstown and Carnegie quadrangles (Pa.) was completed and submitted for publication by E. W. Shaw, who also made an examination of the surficial geology of the Newcastle quadrangle (Pa.) and brought the information on the economic resources of that quadrangle up to date. The report on the survey of the Newcastle quadrangle, which was made by F. W. De Wolf, has been greatly delayed by Mr. De Wolf's duties as acting state geologist of Illinois.

The manuscript for the Claysville folio (Pa.) was completed and submitted by M. J. Munn.

Economic reports on the Punxsutawney, Clearfield, and Houtzdale quadrangles (Pa.) have been published and work in the preparation of the folios and bulletins has been begun by G. H. Ashley. This work, however, is likely to be delayed because of Mr. Ashley's new duties as state geologist of Tennessee.

During the year a number of oil and gas areas in the northern Appalachian region were examined by M. J. Munn, for the purpose of incorporating the results in a general summary report on the oil and gas fields of the Appalachian region.

A paper on the sand and gravel resources of the Pittsburg district was prepared and submitted by E. W. Shaw (in Bulletin 430).

The geologic survey of the Fairfield quadrangle (Pa.) was completed by G. W. Stose, and considerable work was done in the preparation of the text for the folio on the Fairfield and Gettysburg quadrangles. This folio will form one of the series of folios covering the northern Appalachian region. Of these the Mercersburg-Chambersburg folio (Pa.) has already been published, the Pawpaw-Hancock folio (W. Va.-Md.-Pa.) was completed during the year, and the Accident-Grantsville folio (Md.-W. Va.-Pa.), on the most western quadrangles of the series, has been published.

An examination of the iron ores near Dillsburg, Pa., was made by A. C. Spencer and E. C. Harder. A brief report on this work will be found in Bulletin 430.

Considerable progress was made by Florence Bascom in the geologic mapping of the Reading, Boyertown, Honeybrook, and Phoenixville quadrangles (Pa.). During a part of the time Miss Bascom was assisted by E. T. Wherry.

A study of the stratigraphy and paleontology of the western part of the Appalachian Valley in Maryland, Pennsylvania, and New York was continued by Edwin Kirk under the direction of E. O. Ulrich.

In cooperation with the State Geological Survey of New Jersey the maps and text for the Raritan folio were completed and submitted. This folio was prepared by W. S. Bayley, H. B. Kümmel, and R. D. Salisbury.

Southern Appalachian region.—In Alabama the geologic work on the southwestern half of the Cahaba coal field was completed by Charles Butts and the economic report thereon, now in hand, is companion to that on the northern half of the field, already published (in Bulletin 316). A small area in the southeast corner of the Brookwood quadrangle remains to be examined. The geologic mapping of the Bessemer special quadrangle has been nearly finished by Mr. Butts, who has also completed the final work on that portion (comprising about one-third) of the Montevallo special quadrangle which is included in the Cahaba coal field. The text for the folio on the Birmingham quadrangle is practically finished.

In the Ellijay quadrangle (Ga.) Arthur Keith made special studies of the faulted structure of the rocks just southeast of the marble belt, and W. C. Phalen completed the report on the economic geology of the quadrangle, which is to form part of the Ellijay folio.

The examination of the metamorphic area of the Dalton quadrangle (Ga.) was finished by Mr. Phalen, who also accomplished the areal mapping of approximately one-third of the Dahlonega quadrangle.

In cooperation with the state geological surveys of Kentucky and Tennessee the oil fields of those States have been made the subject of a preliminary examination by M. J. Munn, who has in preparation two reports, one relating to each State. In the course of this work a large number of oil and gas fields in northern Tennessee, eastern Kentucky, southeastern Ohio, and adjacent portions of West Virginia have been examined and samples of oil and salt water have been collected from the different oil sands for the purpose of making analyses. Detailed studies have been made of the Campton oil field of Wolfe County, Ky., and of the Steubenville, Cooper, Oil Valley, and Johnson Fork fields of Wayne County, Ky. The field work for these reports is nearly finished and the maps are well advanced.

In November, 1909, S. F. Emmons made a visit to the Ducktown district of Tennessee, and as a result a special study of the geology and ore deposits of this district has been commenced by W. H. Emmons and is now in progress.

The preparation of the final maps and text for the folio on the Woodbury quadrangle (Tenn.) was well advanced by E. O. Ulrich, and areal mapping for the Pikeville special quadrangle was begun by W. C. Phalen.

Additional work on the surficial geology of the Kenova quadrangle (W. Va.-Ohio-Ky.) was done by E. W. Shaw and W. C. Phalen, and the manuscript for the Kenova folio was carried nearly to completion by Mr. Phalen.

In connection with a comprehensive sampling of the coals of the New River and Pocahontas coal fields, for chemical analyses by the technologic branch, David White made a study of the stratigraphic identification and correlation of the coals sampled.

Special studies in the Kings Mountain and Gaffney quadrangles (N. C.-S. C.) were continued by Arthur Keith and D. B. Sterrett. A brief reconnaissance around those quadrangles, in the Gastonia, Hickory, and Statesville (N. C.) and Spartansburg (S. C.) quadrangles, was made by Mr. Keith, who also completed about two-thirds of the mapping of the Cowee quadrangle (N. C.).

A report on the mica deposits of North Carolina was prepared by D. B. Sterrett (in Bulletin 430).

By request, a special examination of the Dan River coal field in Stokes and Rockingham counties, N. C., was made by R. W. Stone, under the direction of M. R. Campbell. A brief report on this investigation has been prepared.

GEOLOGIC WORK IN CENTRAL STATES EAST OF 97°.

In Illinois geologic investigations have been continued in cooperation with the State Geological Survey. The greater part of the expense has been borne by the State Survey, but the results of the studies are available to either Survey. On the part of the Federal Survey, E. W. Shaw has geologically mapped the Murphysboro quadrangle, reviewed the surficial geology of the Herrin and West Frankfort quadrangles, and commenced the preparation of the Murphysboro folio text. An economic report describing the coals of the Murphysboro quadrangle has been placed in the hands of the state geologist, who has forwarded to the Federal Survey a full geologic report, by J. A. Udden, on the Belleville and Breese quadrangles, together with manuscript material, by T. E. Savage, for a bulletin on the geology of the Springfield quadrangle. Mr. Shaw is now engaged in a review of the surficial geology of the Galatia quadrangle. A special field examination of obscure Mississippian and Pennsylvanian sections along the borders of the Murphysboro quadrangle was made by E. W. Shaw, Stuart Weller, and David White.

A study of the stratigraphy of the fire clays of western Illinois was made by E. F. Lines, who thoroughly sampled the clays for chemical analyses and submitted to the State Survey a report covering this work.

The survey of the East Cincinnati and West Cincinnati quadrangles (Ohio-Ky.) was completed by N. M. Fenneman, R. S. Bassler, and J. M. Nickles, under the direction of E. O. Ulrich. The preparation of the folio texts is well in hand.

A report on the Ordovician rocks of the Cincinnati uplift is being prepared by E. O. Ulrich and is nearly ready for publication.

The monograph on the Pleistocene formations of Indiana and Michigan has been finally revised and completed by Frank Leverett and F. B. Taylor. This monograph includes not only a report of the work carried on under the auspices of the Survey by Mr. Leverett and Mr. Taylor, but also the results of several seasons' work by Mr. Taylor partly at private expense and partly under the auspices of the Canadian Survey. It embraces the glacial and lake history not only of Michigan and Indiana but also of neighboring portions of Canada whose history is closely connected with that of those States.

In cooperation with the State Geological Survey of Michigan special studies of the glacial deposits and shores of the old lakes in the Northern Peninsula were made by Frank Leverett. The State Survey was represented by L. H. Wood.

Under the direction of C. R. Van Hise the investigations of the physical and chemical properties of the ores and iron formations of the Lake Superior region were continued by C. K. Leith and W. J. Mead. The results of these investigations have been incorporated in the monograph on the Lake Superior region, which is now in the hands of the editor. Mr. Leith carried on considerable correspondence with the mining companies, in order to procure the latest statistics for this monograph, for which he also obtained additional data regarding geologic boundaries.

A special study was made by Frank Leverett of the pre-Wisconsin drift sheets in southeastern Minnesota, eastern Iowa, and northwestern Illinois. The object was to determine the amount of weathering of the Illinoian drift of the Labrador ice field and the Iowan drift of the Keewatin field. As a result of this study the Iowan drift is tentatively correlated with the Illinoian drift.

Detailed study and areal mapping of the Quaternary deposits of southeastern Wisconsin, together with the mapping of the underlying Paleozoic and pre-Cambrian rocks, were continued by W. C. Alden. The work during the year was done chiefly in Fond du Lac, Dodge, Columbia, Green Lake, Marquette, and Winnebago counties and nearly completed the survey of the area between latitude 42° 30′ and 44° north and east of longitude 90° west. The manuscript for a professional paper covering this area is well advanced. As in previous years, this work was done under the supervision of T. C. Chamberlin.

In cooperation with the state authorities a systematic examination of the coal fields of Missouri was commenced in June by Henry Hinds, assisted by C. T. Lupton.

Work in the preparation of the geologic folio covering the Wyandotte quadrangle (Mo.-Okla.) was well advanced by C. E. Siebenthal. Mr. Siebenthal also made a special examination of the deeper ore deposits of the Joplin district of Missouri.

In Arkansas A. H. Purdue and H. D. Miser mapped the area geology of the southwestern part of the Harrison quadrangle, revised the boundaries in the southwestern part of the Eureka Springs quadrangle, and completed the areal mapping for the Hot Springs special quadrangle. In the office good progress was made in the preparation of the reports on these quadrangles.

The fauna of the basal part of the Fayetteville shale of Arkansas was made the subject of special study by G. H. Girty.

GEOLOGIC WORK IN WESTERN PUBLIC-LAND STATES AND TERRITORIES.

Central States west of 97°.—Some additional studies were made by G. H. Girty of the Carboniferous rocks of Kansas, and a short paleobotanic examination of the Chase and Sumner groups of Kansas was made by David White, for the purpose of procuring fossil-plant evidence bearing on the age of these beds. The fossils obtained are confirmatory of the Permian age of the strata. The southern extension of the search revealed similar Permian evidence at several points in the "Red Beds" of Oklahoma and in the Wichita formation of northern Texas.

A detailed survey of the Pawhuska quadrangle (Okla.) was made by C. D. Smith. The purpose of this work was to determine if possible the relation of the oil and gas accumulations to the structure.

The preparation of the maps and text for the Llano-Burnet folio, covering two quadrangles in central Texas, was practically completed. In the survey of these quadrangles, the geology of which is extremely complicated, A. C. Spencer, Sidney Paige, W. S. Bayley, F. H. Kay, and E. O. Ulrich have participated for longer or shorter periods. A bulletin on the economic resources of this mineral region and a report on the pre-Cambrian geology of the iron ores (in Bulletin 430) were prepared by Sidney Paige.

A detailed study of the quicksilver deposits of the Terlingua region, in Texas, was begun by H. D. McCaskey. The mapping of the western portion of the area covered by the Terlingua special map, which contains all the Lower Cretaceous deposits that have so far proved productive, was completed. During the present season the eastern half of the area will be mapped and a study made of the Upper Cretaceous deposits and the igneous rocks.

The folio covering the Van Horn quadrangle (Tex.) was completed and submitted by G. B. Richardson.

Rocky Mountain region.—The work of classifying and placing valuations on the coal lands of the Rocky Mountain region and Pacific coast States was continued throughout the year. As in previous years, this work was in charge of M. R. Campbell, who supervised all the geologic work of the Survey relating to coal, oil, and gas except in Alaska. During the summer and fall he visited the various parties in the field and gave personal direction to the conduct of the work. During the winter the results of the field examinations were compiled in the office, under Mr. Campbell's supervision. This work involved the preparation of geologic maps, of township plats showing the classification and valuation of the coal lands examined, and of special preliminary reports on the geology and economic resources of the various regions. The following is a brief statement of the work accomplished and of the men directly engaged in its prosecution:

Eastern part of Bull Mountains, Mont. Topographic and geologic surveys for coal-land valuation completed by C. T. Lupton and Henry Hinds, under the supervision of R. W. Stone. Report well in hand.

Part of Milk River coal field, Mont., which lies to the east of the Bearpaw Mountains. Examination by L. J. Pepperberg. Land classified and report partly completed when Mr. Pepperberg resigned to engage in private work.

Hound Creek district of Great Falls coal field, Mont. Mapped and studied by V. H. Barnett, under the supervision of W. R. Calvert. Land classified and brief report submitted for publication.

Upper Powder River coal field, Wyo. Topographic and geologic map of seven townships completed by C. H. Wegemann and R. W. Howell, under the supervision of R. W. Stone. Map and brief report submitted for publication.

Salt Creek oil field, Natrona County, Wyo. Ten townships surveyed by C. H. Wegemann and R. W. Howell, under the supervision of R. W. Stone. Map and report submitted for publication.

Coal field at Aladdin, Wyo. Examined by R. W. Stone.

Wind River coal and oil field, Wyo. Examined by E. G. Woodruff. Lands classified and preliminary report submitted for publication.

Lander oil field, Wyo. Examined by E. G. Woodruff. Lands classified and report submitted for publication.

Rock Springs coal field, Wyo. Examined by A. R. Schultz. Survey completed, preliminary reports published (in Bulletins 341 and 381), and final report well advanced.

Little Snake River coal field, Wyo. Lands classified and brief report prepared by M. W. Ball and Eugene Stebinger (in Bulletin 381).

Black Hills coal field, Wyo. Examined by R. W. Stone.

Standing Rock and Cheyenne Indian reservations, N. Dak. and S. Dak. Examination undertaken at the request of the Bureau of Indian Affairs. Completed by M. A. Pishel, V. H. Barnett, and A. L. Beekly, under the supervision of W. R. Calvert. Reports on valuation have been sent to the Bureau of Indian Affairs. More detailed geologic reports are in course of preparation.

Williams Fork district of Yampa coal field, Colo. Examined by J. A. Davis. Lands classified and report submitted.

Part of Grand Hogback coal field of Colorado between Newcastle and Coal Basin. Examined by A. L. Beekly. Lands classified and report nearly finished.

Anthracite-Crested Butte coal field, Colo. Examined by W. T. Lee. Lands classified and report completed.

South Park and Canon City coal fields, Colo. Lands classified by C. W. Washburne and preliminary reports submitted (in Bulletin 381).

Book Cliffs coal field, Colo. Lands classified by G. B. Richardson.

Trinidad coal field, Colo. Report completed and submitted by G. B. Richardson (in Bulletin 381).

Florence oil field, Colo. Detailed report completed by C. W. Washburne.

Southwestern Colorado. Oil prospects near Dolores and San Miguel rivers examined by C. W. Washburne.

San Juan coal region, N. Mex. and Colo. Detailed examination of certain townships near Monero, N. Mex., by J. H. Gardner. General geologic reconnaissance over southeastern part of field for the purpose of correlating the geologic formations with other formations in this and adjacent fields.

Coal field north of Greeley, Colo. Examined by E. G. Woodruff.

Oil prospects near Mount Pleasant, Utah. Examined by E. G. Woodruff.

Southern Utah coal field. Lands classified by G. B. Richardson.

Coos Bay and Eckley coal fields, Oreg. Examined by J. S. Diller, assisted by M. A. Pishel. Lands classified and preliminary geologic report submitted for publication.

Ontario gas field, Oreg. Examined by C. W. Washburne. Report in hand.

Astoria gas and oil field, Oreg. Examination now in progress by C. W. Washburne.

State of Washington. Practically all the coal fields in this State examined by E. E. Smith, for the purpose of studying the character of the coal and collecting samples for chemical analysis. A report on this subject is nearly ready for publication. Mr. Smith also made a reconnaissance of the Carlton Pass coal field of Washington, at the request of the Forest Service, for the purpose of classifying the coal lands of that area.

Considerable progress in the mapping of the Deadwood and Rapid quadrangles (S. Dak.) was made by Albert Johannsen. Until his resignation in the spring, to accept a professorship in the University of Chicago, Mr. Johannsen also had charge of the petrographic reference collection of the Survey.

A brief examination of Carboniferous sections in the Little Belt Mountains region of Montana was made by W. R. Calvert and G. H. Girty. Problems in Cretaceous stratigraphy in the Crazy Mountains, Montana, were made the subject of a short field conference by several geologists.

The maps and text for the Philipsburg folio (Mont.) were practically completed by F. C. Calkins. The report on the economic geology of this area, which is finished, is by W. H. Emmons.

At the request of the Department of Justice, F. C. Schrader was detailed to examine certain mining prospects in the northern part of Idaho and adjacent parts of Montana. Regarding this investigation Mr. Schrader testified before the grand jury in Spokane, and later in the year prepared a preliminary report on the matter for the use of the post-office inspectors and the Department of Justice.

A study of the copper deposits near Montpelier, Idaho, was made by H. S. Gale, and a report was completed and submitted for publication (in Bulletin 430).

At the request of the Forest Service, mining claims comprising more than 2,300 acres of timber and mineral land in the Clearwater National Forest, Idaho, were examined by F. C. Schrader, and subsequently reports thereon were submitted. Mr. Schrader's observations during this examination also led him to prepare a paper on the occurrence of monazite in northern Idaho, with generalizations on the occurrence of monazite elsewhere in the State (in Bulletin 430).

Some of the areas in Idaho, Utah, and Wyoming which had been withdrawn by the Secretary of the Interior because of the probable existence of phosphate rock were examined by two geologic parties. In northeastern Utah Eliot Blackwelder examined and classified the phosphate withdrawals from Croyden and Devils Slide northward to Huntsville and Eden. A larger party, consisting of H. S. Gale, in charge, R. W. Richards, C. L. Breger, and G. H. Girty, examined and classified the phosphate withdrawals about Montpelier, Idaho, and along the east side of Bear Lake Valley from Georgetown Canyon, Idaho, to Laketown, Utah. On the east this work was extended so as to include the Sublette Mountains and Beckwith Hills in Wyoming and the Crawford Range along the Wyoming-Utah border. Phosphate deposits in the region along Twelvemile Creek, southwest of Woodruff, Utah, were also examined. In this work W. H. Waggaman, of the Department of Agriculture, rendered valuable assistance as chemist, analyzing in the field about 340 samples of phosphate rock. Reports on these phosphate deposits have been completed and submitted for publication (in Bulletin 430).

A brief report (see Bulletin 430) on the salt resources of the Wyoming-Idaho border, embracing Stump Creek, Tygee Creek, and Crow Creek in Bannock County, Idaho, and Salt Creek in Uinta County, Wyo., was prepared by C. L. Breger.

An examination of possible future oil fields in the Virgin River region, Utah, and in the Bighorn Basin, Wyoming, was made by Robert Anderson, who classified the lands in those regions.

A study of the graphite deposits near Brigham, Utah, was made by H. S. Gale, and a report was prepared and submitted for publication (in Bulletin 430).

In the survey of phosphate lands in northern Utah Eliot Blackwelder acquired much new information relating to the stratigraphy and structure of the Wasatch Mountains. Reports and scientific papers embodying these results have been prepared by Mr. Blackwelder.

The study of the areal geology and mines of the Frisco district, Utah, was completed by B. S. Butler and considerable progress was made in the preparation of the report.

Geologic mapping in the San Juan region of Colorado was continued by Whitman Cross, assisted by E. S. Larsen and for a short time by J. H. Gardner. During the season the northeastern portion of the Ignacio quadrangle was mapped and considerable progress was made in the mapping of the San Cristobal quadrangle, which was started the previous year and will be finished during the coming season. The San Juan is an extremely complex volcanic district, and a general report on the volcanic geology, covering the work of several years, is in course of preparation by Mr. Cross. In this study Mr. Larsen, who has since been placed in charge of the petrographic reference collection of the Survey, has continuously rendered assistance. Considerable progress was made by Mr. Cross and W. W. Atwood in the study of the Quaternary geology and physiographic history of the San Juan Mountains. During the winter Mr. Cross prepared a paper on the natural classification of igneous rocks, which was read before the Geological Society of London in June.

Late in the year an examination of certain areas tributary to the Rio Grande in the San Juan Mountains of Colorado was made by E. S. Larsen, at the request of the Forest Service.

In response to a petition addressed to the Secretary of the Interior and signed by nearly every person having important interests in the district, a study of the Breckenridge district of Colorado has been

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Near the close of the year a reconnaissance of some newly developed and promising gypsum deposits in the Rocky Mountain region was begun by E. F. Burchard.

Pacific coast.—During the summer and fall of 1909 the investigations of the California oil fields were continued by Robert Anderson, with R. W. Pack as field assistant. The work was pushed farther beyond the limits of actual production than in previous years, with a view to outlining the areas of possible productive territory in the undeveloped regions adjoining some of the important fields. The early part of the summer was spent in the region surrounding the Carrizo Plain, west of the McKittrick, Midway, and Sunset districts, and the rest of the field season in the Cantua-Panoche region, which extends northward from the Coalinga district. This work resulted in the classification of some tracts as possible oil land and the restoration to entry of large areas of nonoil land which had been temporarily withdrawn pending examination. During the spring of 1910 two reports were issued, one on the geology and oil resources of the Coalinga district, by Ralph Arnold and Robert Anderson (Bulletin 398), and a preliminary report on the McKittrick-Sunset region, by Ralph Arnold and H. R. Johnson (Bulletin 406). A preliminary report on the Cantua-Panoche region was prepared.

Considerable progress was made by B. S. Butler in the completion of the report on the copper-mining district of Shasta County, Cal.

A reconnaissance survey of the gypsum deposits of the Palen Mountains, Riverside County, Cal., was made by E. C. Harder; also a reconnaissance of chromite, manganese, and iron ore deposits in central and western California and western Nevada. Brief reports on these surveys will be found in Bulletin 430.

A detailed examination of the iron ores of the Eagle Mountains, Riverside County, Cal., was made by E. C. Harder and J. L. Rich. A report is in progress. Detailed geologic work in the Randsburg quadrangle (Cal.) was continued by F. L. Hess and some progress was made in the preparation of the report on that area.

The report on the auriferous gravels of California, by Waldemar Lindgren, was sent forward for publication.

At the request of the Forest Service an examination of placer claims in Trinity County, Cal., was made by D. F. MacDonald. These claims included 2,800 acres of supposed mineral ground. A hearing was held from September 1 to September 10 at Redding, Cal.

At the request of the Secretary of War an examination of the underground-water resources of Angel Island, Cal., was made by F. L. Ransome. A brief report on this subject has been submitted.

The geologic mapping of the Ely quadrangle (Nev.) was practically completed by A. C. Spencer and considerable progress was made in made by F. L. Ransome, assisted by E. S. Bastin. The report will be ready for publication by October. A preliminary inspection of the field was made by S. F. Emmons.

A general reconnaissance of the tungsten field in Boulder County, Colo., to obtain information for use in the contemplated report on the tungsten deposits of the United States, was made by F. L. Hess.

The areal geology in the vicinity of Idaho Springs, Colo., was mapped by E. S. Bastin and J. M. Hill, who also made considerable progress in the study of the economic geology of the Central City quadrangle (Colo.).

Special studies of stratigraphic problems in the Trinidad coal field of Colorado were made by F. H. Knowlton and A. C. Peale.

A paleobotanic reconnaissance by David White of the "Red Beds" in the valley of Arkansas River in Colorado and in the Santa Fe quadrangle (N. Mex.) resulted in the discovery of Permian types in portions of the series whose age has, for lack of fossils, hitherto been unknown.

A reconnaissance of the Sylvanite and Fremont mining districts near Hachita, N. Mex., was made by J. M. Hill. (See Professional Paper 68.)

The areal and economic survey of the Silver City quadrangle (N. Mex.) was commenced toward the close of this fiscal year and is now in progress. This work is in charge of Sidney Paige, assisted by J. L. Rich.

Geologic problems in the Raton coal field of New Mexico were studied by F. H. Knowlton and A. C. Peale in connection with investigations of the coal-bearing formations.

A report on a reconnaissance of the ore deposits of northern Yuma County, Ariz., was completed and transmitted by Howland Bancroft, who also submitted a report on the occurrence of quicksilver at Cinnabar, Ariz. (in Bulletin 430).

S. F. Emmons spent a week at Globe, Ariz., studying the geology of that district in the light of underground explorations which have been made since the district was surveyed by F. L. Ransome in 1901–2. As a result of this examination a supplementary report will be prepared by Mr. Ransome.

Brief reports on the occurrence of tungsten minerals near Calabasas, Ariz., and on the placer deposits of Greaterville, Ariz., were prepared by J. M. Hill for Bulletin 430.

Considerable progress was made in the report on the mineral deposits of the Santa Rita and Patagonia mountains of Arizona, which is in course of preparation by F. C. Schrader, assisted by J. M. Hill. The same authors also prepared a special report on the occurrence of molybdenite in these mountains (in Bulletin 430).

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A brief report on an occurrence of platinum in southeastern Nevada was submitted by Howland Bancroft (in Bulletin 430).

An examination of recent underground workings in the Goldfield district of Nevada was made by F. L. Ransome. The report on the survey of this district, made two years ago (Professional Paper 66), appeared in time for distribution at the meeting of the American Mining Congress at Goldfield in October, 1909.

The areal mapping of part of the Sumpter quadrangle, in eastern Oregon, was finished by F. C. Calkins, assisted by J. T. Pardee, and considerable progress was made in the preparation of the maps and report. A paper on the placer deposits of this region was prepared for Bulletin 430 by Mr. Pardee, under the supervision of Mr. Calkins.

An examination of the canyon of Clackamas River above Cazadero, near Portland, Oreg., was made by J. S. Diller, for the purpose of determining the availability of the rock of the canyon walls for the construction of dams. A report on this investigation was published in the daily press of the Pacific coast.

A reconnaissance of the ore deposits in the northeastern part of the State of Washington was commenced by Howland Bancroft. It is expected that the work will be completed during the coming year. Mr. Bancroft also prepared a report on tungsten near Deer Park, Wash. (in Bulletin 430).

GENERAL GEOLOGIC AND PALEONTOLOGIC WORK.

T. W. Stanton has had general supervision of the paleontologic work during the year. In order to make this work of the highest possible service it is necessary to bring the paleontologists and geologists into close touch in the field. Hence most of the field work of the paleontologists is done in connection with geologic parties. The paleontologic work is essential in connection not only with the study of stratigraphic, structural, and areal geology but also with various problems of economic geology. This is notably true of the investigations of oil and coal fields, where the tracing of productive horizons and the correlation of beds from place to place would be impossible without the assistance of the expert paleontologist.

In addition to the aid rendered in the field, a large share of the time of the paleontologists during the office season is occupied in the determination of fossil collections submitted by the field geologists. So fully is their time taken by this routine work that little opportunity remains for the general studies and correlations that are essential for the symmetrical development of the Survey work.

In addition to the supervision of the paleontologic work, Mr. Stanton visited several field parties in South Dakota, North Dakota, Wyoming, and Montana, chiefly those engaged in land-classification surveys, for the purpose of correlating the coal-bearing formations and of studying problems bearing on the late Cretaceous and early Tertiary rocks of the Rocky Mountain region. In cooperation with M. R. Campbell, F. H. Knowlton, W. R. Calvert, and R. W. Stone, Mr. Stanton made a special study of the stratigraphic relations of the Livingston formation of Montana, by means of a reconnaissance trip around the Crazy Mountains. This study resulted in the elucidation of a particularly obscure stratigraphic problem. The formation, which consists of andesitic material, was found to be of small geographic extent and to finger out in various directions into different Tertiary and Upper Cretaceous formations. The details of this investigation have been explained in a report prepared by Messrs. Stone and Calvert. During Mr. Stanton's field work a special study was also made of the Fox Hills sandstone and the overlying Lance formation ("Ceratops beds"), the results of which have been incorporated in a report which has been completed and submitted for publication.

The investigation of the stratigraphy and paleontology of the coal-bearing rocks of the Rocky Mountain region was continued in the field and office by F. H. Knowlton, who also visited numerous field parties in New Mexico, Colorado, Wyoming, and Montana. In addition Mr. Knowlton has been engaged in the preparation of reports on the Laramie flora of eastern Wyoming and the Jurassic flora of the Pacific coast and a catalogue of Mesozoic and Cenozoic plants of North America.

During the year W. H. Dall has continued his studies of the "silex beds" of Florida and the Tertiary faunas of the Pacific coast and the eastern Gulf coast. The collection of American Tertiary fossils at the National Museum is the largest in the world and is constantly consulted by outside paleontologists, as well as by the government paleontologists. Recently valuable accessions have been made, especially from the southeastern States.

Under the joint supervision of F. H. Knowlton and David White the work on the bibliography and compendium of paleobotany has been continued by Miss C. H. Schmidt.

Studies of the Cambrian, Ordovician, and Silurian rocks in central and eastern Pennsylvania were continued by E. O. Ulrich, the principal object being the determination of practical formational boundaries that would be indicated by lithologic criteria and at the same time mark off important stages in the physical and faunal history of the region.

A report on the Cretaceous fossil plants of South Carolina, by E. W. Berry, is nearly finished.

The study of the Mesozoic and Cenozoic Echinodermata of the United States has been continued by W. B. Clark, assisted by M. W. Twitchell. A large amount of new material has been acquired from the work in the Coastal Plain States.

A report on the Tertiary and Cretaceous floras of Georgia has been completed by E. W. Berry and submitted for publication as a professional paper.

A report on the New Madrid earthquake, by M. L. Fuller, has been received.

Considerable progress was made in the preparation of a bibliography of the mineral phosphate industry of the world by C. L. Breger. This bibliography embraces works on the occurrence, mining, treatment, etc., of rock and mineral phosphates, guanos, and artificial phosphatic slags. It is classified by countries and in America by States.

A special study of correlation problems relating to the Devonian rocks of the Allegheny region was made by E. M. Kindle. Type sections in southeastern New York were first examined, and studies were made through the Allegheny Mountain region and in northern Georgia and Alabama. One of the results of this survey has been the preparation of a report, now ready for the press, describing a previously unrecognized southerly extension of the Onondaga fauna. In the office, and for a few days in the field, Mr. Kindle was assisted part of the time by P. V. Roundy, who prepared the fossils for study.

The work of figuring the type Carboniferous specimens of Winchell, which is in charge of G. H. Girty, is nearly finished. The lack of figures of these specimens has been felt by every student of Carboniferous types, and it is expected that this work will be of considerable value. The figures will be accompanied by a reprint of the original descriptions. In the office Mr. Girty has part of the time had the assistance of P. V. Roundy as preparator.

The classification of the physiographic features shown on the topographic maps published by the Survey was completed by W. W. Atwood. This material is arranged from an educational point of view, so as to be of value to those engaged in teaching as well as to those unacquainted with topographic maps. (See circular 9–323 z.)

Geologic problems in eastern, central, and western Wyoming were made the subject of a special investigation by F. H. Knowlton and A. C. Peale. A large amount of material bearing on the correlation of the Upper Cretaceous and Tertiary formations was acquired.

Considerable progress was made by W. D. Johnson in the preparation of a report on the glaciation of the Sierra Nevada. Recent faulting in the Owens Valley of California was also investigated by Mr. Johnson.

A cooperative study of the Eo-Paleozoic rocks of New York, begun several years ago by E. O. Ulrich, of the Federal Survey, and H. P. Cushing and Rudolph Ruedemann, of the New York Geological Survey, was extended around the southern flank of the Adirondack uplift. The results so far as they relate to the "Calciferous" have been published by Messrs. Ulrich and Cushing in the annual report of the director of the New York State Survey.

The special study of the Upper Devonian was continued by H. S. Williams, and considerable progress was made.

A paper on the criteria of downward sulphide enrichment was prepared by F. L. Ransome and read at the meeting of the Canadian Institute at Toronto.

The report by J. P. Smith on the Middle Triassic of America was completed and submitted for publication, and Mr. Smith made good progress in the studies of the Upper Triassic and Lower Triassic.

The geologic map of North America, which has engaged the attention of Bailey Willis for some time, was completed and the engraving has been commenced. The accompanying text is in an advanced state.

Several geologists were detailed to the technologic branch for the purpose of conducting, for the Supervising Architect of the Treasury Department, a survey of the structural materials available in localities where public buildings have been authorized by Congress. About 150 localities were visited and reports forwarded to the Supervising Architect. Among the minerals to which special attention was paid were building and ornamental stones, materials for cement, mortar, concrete, wall plasters, brick, tile, fireproofing wares, and roofing materials. The geologic relations of newly developed deposits were noted, also the advances in the technology of the manufacture and utilization of structural materials and mineral paints.

LAND-CLASSIFICATION BOARD.

Some special features of the work of the land-classification board are discussed on pages 7–10. The detailed statements of the work, with some notes on the other features, are presented below.

PERSONNEL.

The board consists of a general advisory section and such classification sections as may be established from time to time to deal with any particular class of lands. The chairman of the general board is also chairman of the several classification sections and is in charge of the records and office force, consisting of 3 scientific assistants, 6 clerks, and 4 draftsmen.

The advisory board, which is charged with consideration of questions of policy and approval of standards only, consists of the chairman and the chiefs of sections and branches in charge of the field work on which the classifications of the board are based. Its personnel is as follows: A. C. Veatch, chairman; C. W. Hayes, chief geologist; M. O. Leighton, chief hydrographer; M. R. Campbell, chief of section of economic geology of fuels; and Waldemar Lindgren, chief of section of metalliferous ores.

The actual classifications are made by sections composed of three members, the chairman of the board and two members specially qualified in each case to deal with the questions involved in the classification. These sections are at present constituted as follows:

Coal: A. R. Schultz and W. R. Calvert.
Oil: M. J. Munn and Robert Anderson.
Phosphate: F. B. Van Horn and E. O. Ulrich.
Metalliferous deposits: H. D. McCaskey and F. L. Ransome.
Nonirrigable lands: W. C. Mendenhall and J. C. Hoyt.

COAL LANDS.

The year's work in coal-land classification (see pp. 8–9) is shown in detail in the following tables:

Progress of coal-land classification for the year ending June 30, 1910.

[Areas in acres.]

State.	Date.	Total area classified as coal land and appraised.		Total area classified as non-coal land.		Total valuation as fixed for coal land.		Total minimum valuation.		Average price per acre.	
		(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Arizona	July 1.1909										
	July 1,1910										
Arkansas	July 1,1909	60,715		70,041		$1,473,762		$1,214,320		$24.3	
	July 1,1910	60,715		70,041		1,473,762		1,214,320		24.3	
California	July 1,1909										
	July 1,1910		7,720		6,242		$585,086		$154,404		$75.8
Colorado	July 1,1909	488,826	104,298	2,595,851	331,865	14,116,985	2,325,330	7,136,850	2,085,960	28.9	22.3
	July 1,1910	349,264	1,807,521	2,069,923	2,718,871	9,893,425	115,755,958	4,360,010	35,196,015	28.3	64.0
Montana	July 1,1909	457,676	493,931	5,567,533	2,241,210	9,004,115	12,026,847	8,670,651	9,739,919	19.7	24.3
	July 1,1910	405,556	792,351	4,826,109	3,642,754	7,962,915	20,604,859	7,629,451	15,164,461	19.6	26.0
New Mexico	July 1,1909	1,795,918		3,502,931		21,894,731		21,861,171		12.2	
	July 1,1910	1,794,258	7,406	3,368,410	249,748	21,853,231	274,486	21,827,971	148,128	12.2	37.1
North Dakota	July 1,1909	227,795				4,480,295		4,480,295		19.7	
	July 1,1910	227,795			679,075	4,480,295		4,480,295		19.7	
Oregon	July 1,1909			884,617							
	July 1,1910		80	884,617			1,600		1,600		20.0
South Dakota	July 1,1909										
	July 1,1910				4,340,366						
Utah	July 1,1909	416,007		1,197,678		12,743,525		6,258,738		30.6	
	July 1,1910	398,661	67,092	1,167,417	286,942	12,100,205	3,521,591	5,964,610	1,201,591	30.4	52.5
Washington	July 1,1909			627,198							
	July 1,1910			627,198	6,240						
Wyoming	July 1,1909	2,000,114	144,344	4,577,837	1,839,546	41,990,766	16,136,174	34,424,435	2,316,833	21.0	111.8
	July 1,1910	1,355,064	2,936,599	2,659,181	5,738,341	26,696,448	224,672,347	22,627,798	50,093,112	19.7	76.5
Total	July 1,1909	5,447,051	742,573	19,023,686	4,412,621	105,704,179	30,488,351	84,046,460	14,142,712	19.4	41.1
	July 1,1910	4,591,313	5,618,769	15,672,896	17,668,579	84,460,281	365,415,927	68,104,455	101,959,311	18.4	65.0

[a] Under old regulations.

[b] Under new regulations.

Statement of coal-land withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New withdrawals.[a]	Restorations and classifications.[b]	Withdrawals outstanding July 1, 1910.
Arizona		161,280		161,280
Colorado	10,224,368	701,265	4,736,372	6,189,261
Montana	6,692,985	14,619,371	1,103,491	20,208,865
New Mexico	4,160,787		1,216,508	2,944,279
Oregon	379,722		80	379,642
Utah	5,199,843	953,930	338,486	5,815,287
Washington	2,252,087		44,120	2,207,967
Wyoming	13,218,830	3,989,882	4,218,647	12,990,065
	42,128,622	20,425,728	11,657,704	50,896,646

[a] Exclusive of change in form and including 587,306 acres which were rewithdrawn where new data indicated the existing classification to be erroneous.

[b] Exclusive of classification of areas never withdrawn, amounting to 5,457,443 acres, of which 5,019,441 acres of noncoal land are in the old Standing Rock and Cheyenne Indian reservations, North Dakota and South Dakota, and of reclassifications amounting to 4,206,528 acres.

Outstanding coal classification work.—The work of the coal-land board is in arrears to the extent of 7,432,091 acres on which field work is reported as completed, but on which classifications have not been sent to the General Land Office, and to the extent of 20,264,209 acres which are classified under the old regulations but have not been reclassified under the new. Action on most of this work is well advanced and will probably be completed during the coming fiscal year.

Applications for reclassification.—Applications for the reclassification of lands classified as coal land are forwarded to this office by the General Land Office. These petitions allege that the existing coal classification of the lands is erroneous and that they should properly be classed as noncoal lands. In 3 cases during the year the allegation of the applicant was sustained and the lands classified as noncoal. In 3 other cases it was sustained as to a part of the land involved, and in 116 cases the application was denied. There are pending at the end of the year 5 such applications, making a total of 127, which are divided among the several States as follows:

Applications for reclassification of areas classified as coal land.

State.	Approved.	Part approved.	Denied.	Pending.	Total.
Colorado				2	2
Montana	3	1	43	2	49
New Mexico			7	1	8
Utah		2	2		4
Wyoming			64		64
	3	3	116	5	127

OIL LANDS.

The status of the work on oil lands (see p. 10) is indicated in the following table:

Statement of oil-land withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New withdrawals.[a]	Restorations.	Withdrawals outstanding July 1, 1910.
Arizona		230,400		230,400
California	2,270,144	591,062	378,456	2,482,750
Colorado		87,474		87,474
Louisiana	1,451,520		1,036,800	414,720
New Mexico		419,901		419,901
Oregon	74,849			74,849
Utah		1,196,848	615,282	581,566
Wyoming	173,530	223,575	141,644	255,461
	3,970,043	2,749,260	2,172,182	4,547,121

[a] Excluding changes in form of withdrawals.

PHOSPHATE LANDS.

The withdrawals of phosphate lands (see p. 8), by States, are as follows:

Statement of phosphate-land withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New withdrawals.	Restorations.	Withdrawals outstanding July 1, 1910.
Florida		2,400		2,400
Idaho	1,625,425	189,132	712,240	1,102,317
Utah	524,975	8,116	425,546	107,545
Wyoming	2,364,175	202,306	1,184,630	1,381,851
	4,514,575	401,954	2,322,416	2,594,113

MINERAL CLAIMS IN NATIONAL FORESTS.

In a number of cases, involving claims under the mining laws to lands within national forests, the Forester has requested the Geological Survey to make special examinations. Reports on the examination of 29 such claims have been transmitted to the board during the year by the chief of the section of economic geology of metalliferous ores. The land in 17 of these claims was found by the metalliferous section of the land board to be nonmineral, and that in 12 to be only in part mineral land. The total area classified as nonmineral land was 4,237 acres and that as mineral land 1,130 acres.

ACTION ON SPECIAL AGENTS' REPORTS ON MINERAL CHARACTER OF LANDS IN NONMINERAL SELECTIONS.

The Commissioner of the General Land Office has from time to time during the year transmitted reports of special agents of his office regarding the mineral character of nonmineral selections. For the most part these reports have dealt with the coal character of the land, but of the 302 reports that have been received, 2 have related to precious metals, 4 to iron, 2 to phosphate, and 2 to oil. The reports of the special agents were approved in 209 cases, disapproved in 66, and approved as to part of the area involved in 4. The portion of the reports approved involves 75,435 acres, that disapproved 16,880 acres. The action by States is shown in the following table:

Action on special agents' reports on the mineral character of lands in nonmineral selections, year ending June 30, 1910.

[Areas in acres.]

State.	Approved.		Approved in part (number).	Disapproved.		Pending.		Total.	
	Number.	Area.		Number.	Area.	Number.	Area.	Number.	Area.
Arkansas				2	320			2	320
California				2	480			2	480
Colorado	6	880		3	440	4	560	13	1,880
Idaho						1	40	1	40
Montana	39	27,635		12	1,640			51	29,275
New Mexico		80	1		80			1	160
North Dakota						1	80	1	80
Oregon	5	360						5	360
Utah	95	24,840	2	27	8,760	17	3,080	141	36.680
Washington	6	10,840						6	10,840
Wyoming	58	10,800	1	20	5,160			79	15,960
	209	75,435	4	66	16,880	23	3,760	302	96,075

POWER SITES.

The status of the work on power sites (see p. 8) appears in the subjoined table:

Statement of power-site withdrawals.

[Areas in acres.]

State.	Withdrawals outstanding July 1, 1909.	New withdrawals.	Restorations.	Withdrawals outstanding July 1, 1910.
Arizona		107,550		107,550
California		47,819		47,819
Colorado	22,240	182,776	3,467	201,549
Idaho	59.882	171,089		230,971
Montana	46,367	77,029	881	122.515
Nevada		14,091		14,091
New Mexico		14,536		14.536
Oregon	81,118	96,803	1,200	176.721
Utah	34,880	380,671	35,639	379,912
Washington		55,439		55,439
Wyoming	35,383	72.015	4,002	109,396
	279,870	1,219,818	45,189	1,454,499

REPORTS ON RIGHT-OF-WAY APPLICATIONS.

On November 3, 1909, on recommendation of the Commissioner of the General Land Office, the Secretary directed that all right-of-way applications be forwarded to the Geological Survey for report, in order that no application might be approved which would interfere with any valuable power site desired to be withdrawn in aid of legislation. Of the 261 such applications which have been received, 130 were found to affect sites not valuable for power, the lands covered by 73 were included in power-site withdrawals or such stipulations were made as to fully protect the power sites involved, and 58 are now pending, for the most part awaiting the results of field investigations.

REPORTS ON CAREY ACT SELECTIONS.

Twenty applications under the Carey Act have been referred to the board during the year for report as to the feasibility of the proposed irrigation. Adverse reports were made with respect to eleven of these; favorable reports on the remaining nine.

ENLARGED-HOMESTEAD DESIGNATIONS.

Immediately after the passage of the enlarged-homestead act large areas were designated in each of the States affected thereby. These designations did not cover all the lands of the character named in the act, but only those areas which, so far as it was possible from existing information to determine quickly, should be designated. The data on which some of the designations were made proved to be inaccurate, and a correction of the errors by the cancellation of the parts of the designations involved was necessary. Throughout the year an effort has been made to increase designations wherever there was a demand therefor, on the basis either of information already at hand or of that supplied by special field examinations. These field examinations were made not only by the Geological Survey but by the General Land Office. The designations and cancellations during the year are shown below:

Enlarged-homestead designations and cancellations, year ending June 30, 1910.

State.	Total area subject to provisions of act on July 1, 1909.	Additional designations made during fiscal year.	Cancellations of designations erroneously made.	Total area subject to provisions of act on July 1, 1910.
Arizona	26,657,280	....	....	26,657,280
Colorado	20,299,840	3,880	....	20,303,720
Montana	19,957,960	[a] 9,728,366	200	29,686,126
Nevada	49,512,960	....	....	49,512,960
New Mexico	14,808,520	1,138,963	64,140	15,883,343
Oregon	8,346,560	820,400	....	9,166,960
Utah, secs. 1-5 only	7,020,642	308,463	....	6,654,469
Utah, sec. 6	[b] 571,182			[b] 1,245,818
Washington	3,576,960	107,096	282,240	3,401,816
Wyoming	10,676,280	6,276,033	47,640	16,904,673
	161,428,184	18,383,201	394,220	179,417,165

[a] Of which 105,080 acres are based on field examinations by General Land Office.
[b] Based on field examinations by General Land Office.

During the fiscal year 256 petitions for designations under the enlarged-homestead act have been received. These, with the 38 pending at the close of the last fiscal year, make a total of 294, which have been acted on as follows:

Action on petitions under the enlarged-homestead act, year ending June 30, 1910.

State.	Designations made.		Refused.	Pending.	Total.
	Including all lands asked for.	Including only part of lands asked for.			
Arizona			4	1	5
Colorado	1		10		11
Montana	27	35	28	28	118
New Mexico	29	6	22	8	65
Oregon	16	2	3	2	23
Utah			1	1	2
Nevada			1		1
Washington	4	2	12		18
Wyoming	26	10	6	9	51
	103	55	87	49	294

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under an appropriation of $90,000 for "continuation of the investigation of the mineral resources of Alaska." Under this authority the following classes of work were carried on: Reconnaissance and detailed geologic surveys; special investigations of mineral resources; reconnaissance and detailed topographic surveys; investigations of water resources with reference to the supply available for placer mining; and collection of statistics on mineral production.

PERSONNEL.

The personnel of the division varies greatly during the year on account of the transfer of technical employees to and from other divisions of the Survey and the employment of temporary clerks as the work demands. There have been employed throughout the year 1 geologist in charge, 10 other geologists, 4 topographers, and 3 clerks. In addition to these, 3 geologists were employed on per diem salaries for part of the year. Three engineers gave the greater part of their time to the Alaska work. One topographer was added to the Alaska division by transfer from the topographic branch on April 15, 1910. One engineer was detailed to the division from the water-resources branch for a short period during the field season. A draftsman was also employed in the office for four and a half months, 1 clerk for six months, and 5 clerical assistants for short periods of time.

During the season of 1909 the field force included also 2 topographic and 2 geologic field assistants, together with about 30 teamsters, cooks, etc. In addition, several gage readers were employed, who gave only a part of their time to the work. The temporary assistants in the field force for 1910 included 2 geologic field assistants, with about 27 laborers. On June 30, 1910, the division included 1 geologist in charge, 10 geologists on annual salaries and 3 geologists employed at a per diem compensation, 4 topographers on annual salary, 1 assistant topographer on monthly salary, 1 geologic field assistant, 2 engineers, 27 camp hands, and 3 clerks.

FIELD OPERATIONS IN SEASON OF 1909.

Allotments and areas covered.—Fourteen parties were engaged in Alaskan surveys and investigations during the season of 1909 for varying periods of time between March and November. Some of these parties were subdivided in the field, making a total of seventeen parties that were engaged in investigations of various kinds. In addition to these, the geologist in charge spent a part of the summer in Alaska, carrying on geologic investigations and visiting field parties.

During the year 6,190 square miles were covered by exploratory topographic surveys, 5,170 square miles by reconnaissance topographic surveys, and 444 square miles by detailed topographic surveys.[a] Detailed geologic surveys were made of 450 square miles and geologic reconnaissance surveys of 5,500 square miles, while 6,100 square miles were geologically explored. Most of the geologists also spent considerable time in studying special problems connected with the mineral deposits. The investigation of the water supply in placer districts covered an area of approximately 6,600 square miles and included 81 gaging stations maintained and 703 measurements of stream volumes. Fifteen of the twenty-eight mining districts of Alaska which are being developed, including all but two of the most important, were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. These figures include the cost of both field and office work as well as inspection.

Allotments to Alaskan surveys and investigations, 1909-10.

Southeastern Alaska	$10,700
Copper River region	8,200
Kenai Peninsula, Iliamna Lake, and Alaska Peninsula region	27,950
Matanuska region	10,900
Northwestern Alaska, including Seward Peninsula	13,400
Yukon basin	18,850
	90,000

The following table shows approximately the amount of money devoted to each class of investigation. It is not possible to give the exact figures, as in some cases the same party, or even the same man, carried on two different kinds of work; but this statement will help to elucidate the later table, which summarizes the complete areal surveys.

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[a] Exploratory surveys are published on a scale of 1 : 625,000 or 1 : 1,000,000; reconnaissance surveys on a scale of 1 : 250,000 or 1 : 500,000; and detailed surveys on a scale of 1 : 62,500.

Approximate allotment of Alaskan funds to different classes of surveys and investigations, 1909–10.

Geologic reconnaissance and exploratory surveys	$31,800
Detailed geologic surveys	9,200
Special geologic investigations	2,500
Topographic reconnaissance and exploratory surveys	11,500
Detailed topographic surveys	15,000
Investigation of water resources	8,300
Collection of statistics of mineral production	1,500
Miscellaneous, including clerical salaries, administration, inspection, instruments, and office supplies and equipment	10,200
	90,000

Allotments for salaries, field expenses, and office salaries are shown in the following table. The scientific and technical salaries include those of geologists, topographers, and engineers. Salaries of temporary employees are included under field expenses.

Allotments for salaries, field and office expenses, 1909–10.

Scientific and technical salaries	$30,720
Field expenses, including equipment and supplies	50,660
Clerical and other office salaries	8,620
	90,000

The following table shows the progress of Alaskan surveys since the beginning of systematic work in 1898:

Progress of surveys in Alaska, 1898–1909.[b]

Year.	Appropriations.	Areas covered by geologic surveys (square miles).			Areas covered by topographic surveys (square miles).[b]			Lines of levels (miles).	Bench marks set.	Investigations of water resources.	
		Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000).	Detailed (scale 1:62,500).	Exploratory (scale 1:625,000 or 1:1,000,000).	Reconnaissance (scale 1:250,000; 200-foot contours).	Detailed (scale 1:62,500; 25, 50, and 100 foot contours).			Gaging stations maintained part of year.	Stream-volume measurements made.
1898–99	$46,189.60	9,500			12,840	2,070					
1899–1900	25,000.00	6,000			8,690						
1900–1	60,000.00	3,300	6,700		630	11,150					
1901–2	60,000.00	6,200	5,800		10,200	5,450					
1902–3	60,000.00	6,950	10,050		8,330	11,970	96				
1903–4	60,000.00	5,000	8,000	96		15,000					
1904–5	60,000.00	4,050	3,500		800	6,480	480	86	19		
1905–6	80,000.00	4,000	4,100	536		4,880	787	202	28		
1906–7	80,000.00	5,000	4,000	421		13,500	40			14	286
1907–8	80,000.00	2,600	1,400	442		6,120	501	95	16	48	457
1908–9	80,000.00	2,000	2,850	604		3,980	427	76	9	53	556
1909–10	90,000.00	6,100	5,500	450	6,190	5,170	444			81	708
	781,189.60	60,700	51,900	2,549	47,680	85,770	2,775	459	72		
Percentage of total area of Alaska		10.35	8.85	0.44	8.13	14.63	0.47				

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[a] The areas presented in this table differ somewhat from those previously published. This is in part due to the reclassification of the work and in part to the fact that areas have been more carefully scaled off the map than was previously done.

[b] In addition to the above, the International Boundary Survey and Coast and Geodetic Survey have made surveys of parts of Alaska.

The above table presents the progress of Alaskan surveys and investigations so far as is possible in tabular form and in percentages of the total areas which have been mapped geologically and topographically. From 1904 to 1908, inclusive, much of the appropriation was allotted to detailed surveys. There being, however, great need for the investigation of new regions, nearly half the appropriation in 1909 was spent on exploratory and reconnaissance surveys. As a consequence, over 11,000 square miles were covered during the year by topographic and geologic exploratory and reconnaissance mapping. This large amount of exploratory surveying has been done, however, at the cost of curtailing much detailed work for which there is urgent demand.

General investigations.—The field investigations of Alfred H. Brooks, geologist in charge of the division, covered the period from about June 25 till October 1. Of the time actually devoted to field work, about two weeks was spent with Mr. Moffit and Mr. Capps on the geology of the Nizina district. A month was then occupied in making an overland trip through the Copper and Tanana valleys to Fairbanks. During this journey special attention was given to the matter of selecting areas for subdivisional surveys. About a week was spent at Fairbanks in making a hasty examination of the lode deposits and in visiting the Prindle party. Later, the return journey to the coast was made by way of Yukon River and White Pass. About a week was spent with Mr. Knopf and Mr. Bagley, who were surveying near Eagle River, in the Juneau district.

In the office Mr. Brooks has given a large part of his time to administrative and routine work, in which he was aided by R. H. Sargent, who supervised the Alaskan topographic surveys. During Mr. Brooks's absence in the field E. M. Aten looked after the office work and also rendered valuable services in the office routine and in the compilation of the mineral statistics of Alaska. About one month in all was devoted to the continuation of the work on the Mount McKinley report. A large part of Mr. Brooks's time during the winter months was given to a study of the distribution of and markets for coal in the countries bordering the Pacific Ocean. Some of the results of these investigations are contained in the annual progress report (Bulletin 442).

By instructions from the Secretary, Mr. Brooks and Mr. Sargent made a comprehensive scheme for subdivisional surveys in Alaska and submitted estimates of cost. On the basis of this estimate an appropriation of $100,000 for surveys of public lands in Alaska was made in the sundry civil act. This work is to be carried on by the Geological Survey and the General Land Office in cooperation. The money does not become available till July 1, but plans are made to start surveys in the Fairbanks district as soon as parties can be put in the field after that date. Mr. Sargent has been charged with the execution of these plans and is assisted by C. L. Nelson, S. G. Lunde, and W. N. Vance, who have been detailed from the topographic branch. It is believed that these agricultural surveys will result in the homesteading and cultivation of considerable good agricultural land, which should reduce, to some extent, the cost of living in many of the mining centers. It is estimated that Alaska contains a possible agricultural and grazing area of 15,000 or 20,000 square miles, and these land surveys should be pushed to completion as rapidly as possible.

Southeastern Alaska.—The detailed geologic mapping of the Berners Bay district was completed by Adolph Knopf, who also completed the survey of about two-thirds of the gold belt between Berners Bay and Juneau. Mr. Knopf mapped a total area of about 125 square miles.

Surveys for the topographic base maps needed for the detailed geologic work between Berners Bay and Juneau were made by J. W. Bagley and R. E. Johnson. Work was continued in this field from May to October, and about 154 square miles was surveyed, being about nine-tenths of the total area.

C. W. Wright was employed for about three months in the office on his report on the copper deposits of the Kasaan Peninsula and Copper Mountain districts. He was called to Sardinia on private work before the report was finished, but arrangements have been made by which he will complete the report during the next fiscal year.

Copper River region.—F. H. Moffit, assisted by S. R. Capps, made a detailed survey of the copper and gold bearing belt covered by the Nizina special topographic map. Field work began the first of July and continued until the middle of September, during which time 325 square miles was mapped.

Kenai Peninsula and Prince William Sound.—A reconnaissance of the Prince William Sound region was completed by U. S. Grant in 1908, but in 1909 some additional data were obtained. Most of the season was devoted by Mr. Grant, assisted by D. F. Higgins, to a reconnaissance of the southeastern part of Kenai Peninsula. In the course of this work the newly discovered lode districts of Moose Pass and False Creek were visited. In all about 600 square miles was covered by geologic and topographic surveys.

Southwestern Alaska.—W. W. Atwood completed his report on the geology and mineral resources of the Alaska Peninsula, which was transmitted for publication on June 27. This report includes not only the results of his own investigations in that portion of Alaska, but a compilation of all previous work done in this portion of the district by members of the Geological Survey.

Iliamna and Clark lakes region.—As a part of the general plan to extend reconnaissance surveys as rapidly as possible, such work was undertaken in the Iliamna and Clark lakes region. D. C. Witherspoon, assisted by C. E. Giffin, made a topographic survey of an area of 5,150 square miles, while G. C. Martin, assisted by F. J. Katz, mapped the geology of about 3,000 square miles in the same field.

Matanuska Valley.—In accordance with the policy of surveying the more valuable coal fields as soon as circumstances permit, the preparation of the base map of the Matanuska field was undertaken this year. This survey was made by R. H. Sargent, assisted by J. B. Leavitt, who covered some 196 square miles.

Yukon basin.—The reconnaissance geologic mapping of that part of the Fairbanks quadrangle lying north of the Tanana was completed by L. M. Prindle, assisted by B. L. Johnson. The Prindle party mapped about 2,000 square miles and also made a study of the newly discovered auriferous lode district near Fairbanks.

In 1907 investigation of the water resources of the Yukon-Tanana district was begun in the Fairbanks region. This work was extended by C. E. Ellsworth in 1909. For the purpose of obtaining data regarding the spring run-off when the melting of the snow takes place in March Mr. Ellsworth proceeded to Fairbanks over the ice. He devoted the early part of the season to a study of the water conditions of the streams tributary to the Chatanika, and later proceeded overland to the Circle district. The remainder of the season was devoted to stream gaging in the Circle and Fairbanks regions. Twenty-one gaging stations were maintained during the whole or part of the season, and 232 measurements of stream volume were made. This work furnishes data in regard to the run-off of about 3,000 square miles.

Reconnaissance surveys were made of the Koyukuk and Chandalar district in 1899. The rich placer discoveries in this district during the last few years made a reexamination imperative. A. G. Maddren was assigned to this work, and in the course of the season visited all the productive placers in the field and also made geologic and topographic surveys of some 500 square miles.

Norton Bay region.—An exploratory survey of the region lying north and east of Norton Bay and between the lower Yukon and Seward Peninsula was made by P. S. Smith, assisted by H. M. Eakin. An area of about 5,000 square miles was covered by this party, in addition to which a more detailed geologic and topographic survey of some 200 to 300 square miles was completed.

The investigation of the water resources of Seward Peninsula, so far as they refer to placer mining, was begun in 1906 and continued through 1907, 1908, and 1909. In 1909 the work was in charge of F. F. Henshaw, assisted by G. L. Parker, who maintained 60 gaging stations and made 471 stream-flow measurements. Stream gaging has now been continued through four years, which gives fairly definite results regarding run-off. A report is in preparation by Mr. Henshaw, which will summarize all the data and also discuss the methods of mining.

Collection of statistics.—The work of collecting statistics of gold, silver, and copper production from the operators begun in 1906 was continued through 1909. It is gratifying to note that the operators are showing an increased interest in this work, and that most of the large producers are now furnishing the desired information in regard to production. During 1909 practically every lode mine of importance in the Territory furnished the statistical data requested. There are still many placer miners who have neglected to reply to the inquiries, which are of necessity sent by mail.

FIELD OPERATIONS FOR SEASON OF 1910.

Under an allotment of $90,000 thirteen parties were dispatched to Alaska during the months of March, April, May, and June. One of these parties is carrying on detailed topographic surveys in southeastern Alaska. Another is doing detailed geologic work in the same region. One geologic party and two topographic parties are making reconnaissance surveys in the upper Copper and Susitna basins. Two parties are making detailed geologic surveys of the Matanuska coal field and adjacent areas. One party has begun a geologic and topographic reconnaissance survey of the region bounded by Tanana River on the north, the Delta on the east, the Nenana on the west, and the Alaska Range on the south.

The investigation of the water resources of the Fairbanks, Birch Creek, and Rampart regions is being continued, and similar work has been started in the Fortymile district. A party is also engaged in making an exploratory survey from the Koyukuk to the Kobuk and thence to Seward Peninsula. The survey of the Innoko placer district made in 1907 is being extended. Some gaging stations are being continued in Seward Peninsula.

OFFICE WORK.

During the year two bulletins (Nos. 410 and 417) which contain results of the work of the Alaska division have been issued. Both contain maps and in addition there have been issued separately as sale publications two reconnaissance maps, those of the Rampart and Fairbanks quadrangles.

The following publications are in press:

Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska, by P. S. Smith (Bulletin 433).

The Fortymile quadrangle (reconnaissance map 1, by E. C. Barnard), new edition; scale 1:250,000; contour interval, 200 feet.

There have been submitted for publication the following manuscripts:

The Yakutat Bay earthquake of September, 1899, by R. S. Tarr and Lawrence Martin (Professional Paper 69).

Mineral resources of Alaska; report on progress of investigations in 1909, by Alfred H. Brooks and others (Bulletin 442).

Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins (Bulletin 443).

Geology and mineral resources of the Berners Bay region, Alaska, by Adolph Knopf.

Geology and mineral resources of the Nizina district, by F. H. Moffit and S. R. Capps.

Geology and mineral resources of parts of the Alaska Peninsula, by W. W. Atwood.

Geologic reconnaissance in the southeastern part of Seward Peninsula and the Norton Bay-Nulato region, by P. S. Smith and H. M. Eakin.

The Circle quadrangle (reconnaissance map), by D. C. Witherspoon, T. G. Gerdine, and J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

The following reports are in hand:

Geology and mineral resources of the Nome and Grand Central quadrangles, by F. H. Moffit and P. S. Smith (75 per cent completed).

Geology of the Fairbanks district, by L. M. Prindle (75 per cent completed).

The Mount McKinley region, by Alfred H. Brooks and L. M. Prindle (Professional Paper 70; 95 per cent completed).

Geology and ore deposits of the Kasaan Peninsula and Copper Mountain region, Prince of Wales Island, by C. W. Wright (60 per cent completed.)

The Koyukuk and Chandalar placer districts, by A. G. Maddren (75 per cent completed).

Geologic reconnaissance in the Iliamna and Clark lakes region, by G. C. Martin and F. J. Katz (80 per cent completed).

Geology of the Fairbanks quadrangle, by L. M. Prindle (50 per cent completed).

The water supply of Seward Peninsula, by F. F. Henshaw (30 per cent completed).

Geology of the Glacier and Lituya bays region, by F. E. Wright and C. W. Wright (30 per cent completed).

The stratigraphy of the Upper Cretaceous and Tertiary coal horizons of Alaska, by W. W. Atwood (10 per cent completed).

The following maps have been completed during the year. Some will be held for the survey of additional areas before publication. The office work on maps is completed to date.

Kasaan special map, Prince of Wales Island; scale 1: 62,500; contour interval 50 feet. Topography by R. H. Sargent, J. W. Bagley, and D. C. Witherspoon.

Copper Mountain special map, Prince of Wales Island, by R. H. Sargent; scale 1: 250,000; contour interval 50 feet.

Eagle River special map, by J. W. Bagley; scale 1: 62,500; contour interval 50 feet. Additional areas to be surveyed before publication.

Reconnaissance map of Iliamna and Clark lakes region, by D. C. Witherspoon and C. E. Giffin; scale 1 : 250,000; contour interval 200 feet.

Matanuska special map, by R. H. Sargent; scale 1: 62,500; contour interval 50 feet.

Nabesna quadrangle (reconnaissance map), by D. C. Witherspoon and J. W. Bagley; scale 1 : 250,000; contour interval 200 feet. Additional areas to be surveyed before publication.

Gardiner Creek quadrangle (reconnaissance map), by D. C. Witherspoon and J. W. Bagley; scale 1:250,000; contour interval 200 feet. Additional area to be surveyed before publication.

Map of Seward Peninsula, by U. S. Geological Survey; scale 1: 500,000; contour interval 200 feet.

GEOLOGIC RESULTS.

Mr. Knopf's studies in the Berners Bay region show that a part of the rocks of the Juneau gold belt, all previously assigned to the Carboniferous, are Jurassic—a result which indicates a very close similarity between the geology of this field and that of the California Mother Lode district. The work of Mr. Grant and Mr. Higgins shows that the metamorphic rocks of Kenai Peninsula, like those of Prince William Sound, are divisible into two large groups. The Iliamna and Clark lakes region has been found by Mr. Martin and Mr. Katz to be made up largely of lavas and intrusive rocks, with some Mesozoic and Paleozoic sediments. The cupriferous mineralization seems to be similar in character to that of Prince of Wales Island, and the copper ores occur near the contacts of crystalline limestones and intrusives. Messrs. Moffit and Capps have shown that the Jurassic rocks of the Nizina district are locally auriferous, and this fact suggests that the mineralization may belong to the same epoch as that of southeastern Alaska. In the Fairbanks district Mr. Prindle's studies have shown that there were two periods of intrusion by quartz veins and that the later one was accompanied by auriferous mineralization. In the Koyukuk Mr. Maddren found evidence of a much wider extent of glaciation than was previously supposed. The work of Mr. Smith and Mr. Eakin shows that the region between Norton Bay and Seward Peninsula is largely occupied by Cretaceous rocks. Of significance is their determination of the Mesozoic age of the auriferous mineralization on Bonanza Creek.

DIVISION OF MINERAL RESOURCES.

What is now the division of mineral resources was organized in 1882 as the division of mining statistics and technology under the direction of Albert Williams, jr. Mr. Williams continued in charge until 1885 and was succeeded by David T. Day, who remained in charge until August, 1907, when (at his own request) he was relieved of the administrative duties. Since that time the work of the division has been carried on under the supervision of Edward W. Parker as statistician in charge. At the time that Mr. Parker took charge of the division Waldemar Lindgren was placed in charge of the section relating to metalliferous statistics (except iron).

The statistical reports of this division cover the calendar year. The first report was published in 1883 and covered the calendar year 1882. As the statistics are compiled for the calendar year, the expenses of compilation and publication are necessarily distributed through two fiscal years. On account of the great development in the mining industry during the past few years it has been necessary to increase the size of the publications, and the reports for 1907 and 1908 have been issued in two octavo volumes each. The report for 1909 will also be published in two volumes.

Since 1906 the annual appropriation "for the preparation of the report on the mineral resources of the United States" has been $75,000. While these reports are necessarily to a large extent statistical compilations, the effort in recent years has been toward making them also a storehouse of information regarding the occurrence, development, and utilization of the mineral products of the country. It seems that the knowledge of what are the resources of the future is even more essential to our economic development than the record of the past as shown in the statistical compilations. In carrying out this idea the cooperation with the division of geology has been most helpful. The geologists and assistant geologists chosen to aid in the preparation of the report on mineral resources have been those who have specialized in these lines of investigation, and their combined work, having the more scientific bearing in geology and the economic bearing in mineral resources, has been mutually beneficial.

The report for 1908, of two volumes, contains a total of 1,715 pages. Among the important contributions to this report were maps showing the occurrence of the different varieties of iron ores and of petroleum and natural gas, similar to the maps showing the distribution of coal throughout the United States and of the precious and semiprecious metals in the Western States, which were published in the report for 1907. It is proposed to prepare similar maps for future reports showing the distribution of the varieties of stone suitable for building purposes and of materials suitable for cement manufacture.

For the statistical canvass covering the calendar year 1909 a cooperative plan between the Geological Survey and the Bureau of the Census was arranged and approved by the Secretaries of the Departments of the Interior and of Commerce and Labor. This plan includes in the first place the furnishing by the Geological Survey to the Census Bureau of all its complete lists of mineral producers throughout the country. A supplemental schedule for the statistics of production was printed for the use of both the Census and the Survey, the expense of printing being borne by both bureaus in an agreed proportion. The supplemental schedules are collected by the special agents of the Census at the same time they are collecting the general schedules required for the Census Bureau, and are transmitted by the Census Bureau to the Geological Survey for the tabulation of the statistics of production. This tabulation is being done by the division of mineral resources, and the Census Bureau will accept the results as furnished by the Survey. On account of the more detailed information required by the Census Bureau, and because of the fact that practically all the work is being done by special agents in the field, the completion of the report will necessarily be delayed beyond the usual date of publication, but the schedules as transmitted by the Census Bureau have been in the main satisfactorily filled out and less correspondence has been necessary than when the work is done by mail. Up to June 30, 1910, the percentage of schedules received was 25.80. Comparisons with the previous year for the more important subjects for which figures for both years are available are as follows:

Schedules received from producers, June 30, 1909 and 1910.

Industry.	Schedules received.	
	June 30, 1909.	June 30, 1910.
	Per cent.	*Per cent.*
Building stone	97	26
Clay working	98	35
Coal	98	26
Coke	100	15
Iron ores	100	24
Natural gas	90	43
Quicksilver	99	33

A few subjects were omitted from the cooperative agreement with the Census Bureau. These were sand and gravel, mineral waters, aluminum, and briquets. The report on sand and gravel has been completed and transmitted to the printer. Statistics for the reports on mineral waters and briquets have been completed, and the reports will be transmitted to the printer early in July. The Survey also prepared a preliminary report on cement production. This was done on the request of the cement producers for an early publication of the statistics for 1909. A special report on the distribution of Lake Superior iron ores, accompanied by a map, was prepared and transmitted to the printer in May. An important part of the work during the last fiscal year has been the preparation of a chapter on the useful minerals of the United States, similar to those published in the reports for 1882 and 1887. Since the publication of the chapter in the 1887 report a large amount of information has been made available through the work of the Geological Survey and of the state geologists, and it is believed that this publication will be of much value.

During the month of January preliminary statistics of production in 1909, with reviews of the trade during the year, were given to the press in the form of special bulletins on the following subjects: Gold and silver; copper, lead, and zinc; cement; coal; and petroleum.

A considerable portion of the time of the specialists was consumed in answering technical inquiries and in making examinations of numerous mineral specimens submitted by different persons for determination. Such information is freely given where a chemical analysis or assay is not necessary, and it is the endeavor of those in charge to answer all such inquiries as promptly as possible.

In the section of metal statistics, under the charge of Waldemar Lindgren, statistics of the annual production of all metals except iron are collected. H. D. McCaskey has the supervision of the local offices in Denver, Salt Lake City, and San Francisco, which are in charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, respectively. It is the duty of these offices to collect data of mine production by direct correspondence with the producers and to keep in constant touch with the mining industry in their respective territories. C. E. Siebenthal is in charge of the collection of statistics from lead and zinc smelters and also obtains by correspondence the production of the lead and zinc mines in the Central States. B. S. Butler gathers the statistics from copper smelters and also from the mines of Michigan. F. L. Hess has in charge the collection of statistics relating to the rarer metals, such as tungsten, tin, arsenic, and antimony. In addition to his duties mentioned above, Mr. McCaskey collects the statistics from the smelting works producing quicksilver and gathers the data from the gold and silver mines in the Eastern States. D. T. Day prepares a report on platinum.

The reports on gold, silver, copper, lead, and zinc are issued in two forms. The first contains what are termed the smelter reports, based on actual production of metals as reported by the smelters; the second, which is termed the mine report, is based on the returns from the individual mines and contains an epitome of the mining operations and output by quantity of metal and tons of ore in all the mining camps in the country. Thus, the volume "Mineral resources" contains, in addition to the figures of actual smelter production, a detailed account of the condition of the mining and smelting industry throughout the United States. All these reports were issued in the last months of the calendar year except the mine reports from the Western States and the general report on gold and silver, which were not published until January, 1910. For all the metals, however, preliminary statements of production had been issued in the first half of 1909. On January 1, 1910, preliminary statements were issued giving the approximate production in 1909 of copper, lead, zinc, quicksilver, and tungsten, and a few days later a preliminary account of the gold and silver industry was issued in conjunction with the Bureau of the Mint.

In accordance with the plans for cooperation between the Geological Survey and the Census Bureau for the collection of metal statistics for 1909 the agents of the latter bureau are now collecting the data on production of mines and smelters for the Geological Survey. As complete figures have not yet been received at the close of the fiscal year, it has not been possible to follow the usual custom of publishing the correct totals at the end of the fiscal year, in advance of the final, more elaborate reports.

In addition to his administrative duties as statistician in charge, Mr. Parker prepares the reports on the production of coal and on the manufacture of coke. David T. Day continues with the division as expert in charge of the work on petroleum and natural gas. He is also preparing the report for 1909 on the allied subjects—asphalt and bituminous rock. This report was formerly prepared by J. A. Taff, who has resigned from the Survey. Jefferson Middleton supervises the preparation of the report on the clay-working industries. The reports on the production of iron and manganese are prepared by E. C. Harder, assistant geologist. E. F. Burchard, assistant geologist, has charge of the reports on building stones and other structural materials, mineral paints, and several other subjects. Samuel Sanford supervises the preparation of the chapter on mineral waters and is also preparing the special chapter on the useful minerals of the United States. F. B. Van Horn, assistant geologist, supervises the work on phosphate rock and fuller's earth, and the following members of the Survey are preparing reports on minor but important mineral substances: J. S. Diller, geologist, asbestos and talc and soapstone; W. C. Phalen, assistant geologist, abrasive materials, aluminum and bauxite, bromine, grindstones and whetstones, salt, sodium and potash, and sulphur and pyrite; E. S. Bastin, assistant geologist, flint and feldspar and graphite; D. B. Sterrett, assistant geologist, mica, monazite and zircon, and precious stones; and C. A. Davis, peat.

In the investigation of the petroleum resources of the United States, carried on by David T. Day, representative samples of petroleum were collected from the Mid-Continent or Kansas and Oklahoma oil field, and in cooperation with the state geologists similar samples were collected from West Virginia and Louisiana. These were submitted to chemical analysis by the uniform system of examination adopted by the Geological Survey in conformity with the recommendations so far made by the international commission for the unification of petroleum-testing methods. Many samples of petroleum sent in by field geologists were similarly examined. In all, 130 specimens were analyzed, and in the course of the work 2,040 individual determinations were made. In cooperation with the division of geology field examinations of the occurrence of petroleum and natural gas were made in Utah, Louisiana, Texas, and New Mexico. The petroleum section also cooperated with the technologic branch in the development of methods of investigation of California petroleum and in the collection and examination of representative fuel oils for use in the navy.

DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

Routine work in the laboratory has necessarily followed well-established lines. During the year 138 quantitative analyses were reported and 678 qualitative determinations, chiefly of minerals sent for examination by persons not connected with the Survey. Analyses which proved of special interest were those of two tin minerals from Alaska, a new mineral from Colorado allied to amblygonite, the rare mineral thaumasite from a new locality in Utah, and a new mercury mineral from Texas. These analyses were made by W. T. Schaller.

The investigation of the new titanate of iron, which was last year discovered by Chase Palmer in material received from Arizona, has been concluded. The mineral is named arizonite and a description of it has been published by Mr. Palmer.

A study of peat and bog water, with special reference to the humus acid problem, is being made by Mr. Palmer.

A new method for the accurate analysis of natural phosphate rock was worked out by George Steiger, who made an analysis of a composite sample of phosphate rock for the National Fertilizer Association. Additional investigations on the colorimetric determination of fluorine were also made by Mr. Steiger.

The recalculation of the atomic weights was completed by F. W. Clarke and has been published by the Smithsonian Institution. A paper by the same author on chemical denudation has also appeared.

The study of the California tourmaline field was continued by W. T. Schaller, who also prepared a discussion of the composition of the rutile-tapiolite group of minerals.

Investigations of certain minerals containing elements which recent technical developments have rendered important (tungsten, vanadium, molybdenum, uranium, titanium, columbium, tantalum, thorium, and the rare earths) have been conducted by R. C. Wells. It is proposed to publish certain of these results in a bulletin in conjunction with crystallographic and geologic discussions of the minerals by W. T. Schaller and F. L. Hess. Mr. Wells has also published a paper on hydrogiobertite, a basic magnesian carbonate, which has been identified for the first time in this country.

Investigations in the physical laboratory have been conducted as heretofore by C. E. Van Orstrand. The experimental work consisted of a continuation of the experiments on elasticity and diffusivity of metals at various temperatures. The theoretical work consisted largely in a study of the theory of homogeneous stress and strain as applied to rock cleavage. Progress has been made in the preparation of a complete table of the probability integral and its reverse.

Researches on geophysical problems were continued by G. F. Becker, chief of the division. He also published a paper on the origin of the gold of the Witwatersrand and, with Mr. Van Orstrand, "Smithsonian mathematical tables, hyperbolic functions." A second edition of the latter work is already called for and it is undergoing revision at the hands of the authors.

Four bulletins have been issued from this division during the year—Nos. 401, 405, 419, and 422. Titles and brief notes on these bulletins are given on pages 19 and 21. The Smithsonian Institution has also published a paper by Mr. Becker entitled "The age of the earth."

TOPOGRAPHIC BRANCH.

ORGANIZATION.

The organization of the topographic branch remained the same as at the close of the last fiscal year until June 1, when Sledge Tatum was placed in charge of the Rocky Mountain division and E. C. Barnard was detailed to the State Department for work on the United States and Canada Boundary Survey. The branch is now organized as follows:

Chief geographer, R. B. Marshall.
Atlantic division, Frank Sutton, geographer in charge.
Central divison, W. H. Herron, geographer in charge.
Rocky Mountain division, Sledge Tatum, geographer in charge.
Pacific division, T. G. Gerdine, geographer in charge.
Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and F. E. Matthes, topographers.

PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 1 geographer, 19 junior topographers, 2 assistant topographers, and 1 draftsman. It was reduced 41 by transfers and resignations. With these changes the technical force now includes a chief geographer, 10 geographers, 47 topographers, 36 assistant topographers, 58 junior topographers, and 10 draftsmen. One geographer, 8 topographers, and 4 assistant topographers are on leave without pay. In addition to the men named above 95 technical field assistants were employed during the whole or a part of the field season.

PUBLICATIONS.

The work of the topographic branch is represented in the following publications issued during the year: Bulletins 399, 411, and 421; 93 new topographic maps. Titles and brief summaries of these publications are given on pages 19–21.

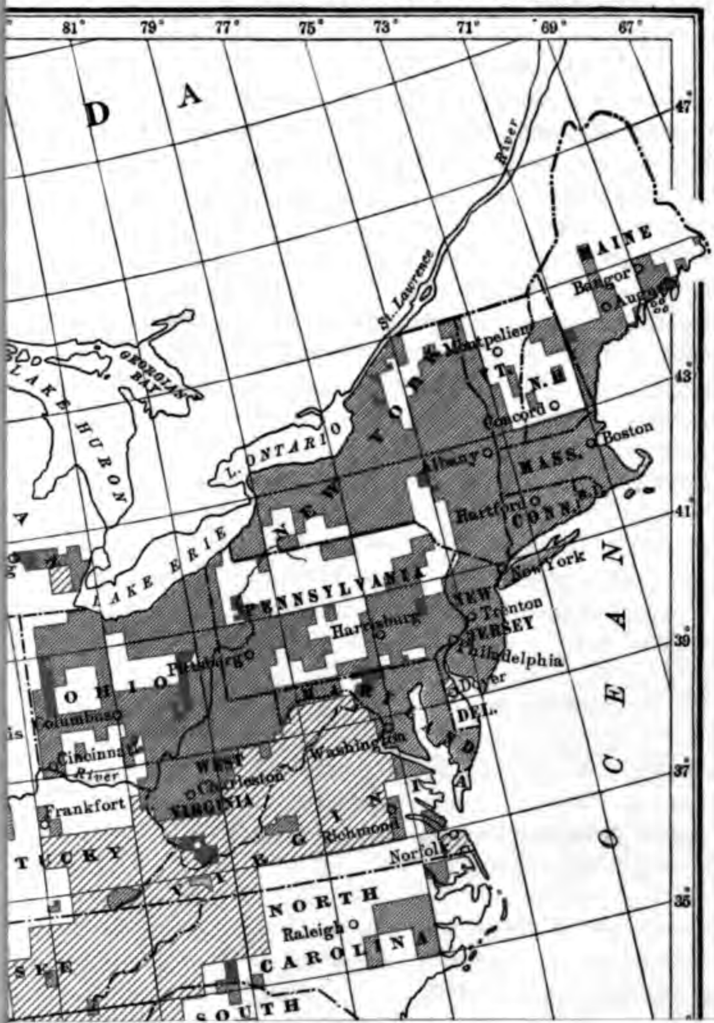
SUMMARY OF RESULTS.

The condition of topographic surveys to July 1, 1910, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 32,808 square miles, making the total area surveyed to date in the United States 1,107,765 square miles, or about 36.5 per cent of the entire country. In addition 3,731 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 36,539 square miles.

Triangulation stations to the number of 156 were occupied, of which 124 were permanently marked; and in addition 141 points were located by intersections. There were run 2,762 miles of primary

THIRTY-FIRST ANNUAL REPORT PLATE II



traverse, in connection with which 454 permanent marks were set. In the course of this work 23,400 square miles were covered by primary control.

In connection with these surveys 5,216 linear miles of primary levels were run, making the total amount of primary and precise leveling done since the authorization of this work by Congress, in 1896, 224,432 miles.

The area covered by topographic surveys in Alaska during the fiscal year 1909–10, as reported in detail on pages 52–56, was about 11,804 square miles—444 for publication on the scale of 1:62,500, 5,170 for publication on the scale of 1:250,000, and 6,190 for publication on the scale of 1:625,000 or 1:100,000.

Present condition of topographic surveys of the United States and new areas surveyed in 1909–10.

State.	New area surveyed in 1909–10.	Total area surveyed to July 1, 1910.	Percentage of total area of State surveyed to July 1, 1910.
	Sq. miles.	*Sq. miles.*	
Alabama		18,283	35
Arizona	45	63,478	56
Arkansas		20,798	39
California	8,183	92,914	59
Colorado	1,221	41,751	40
Connecticut		4,965	100
Delaware		1,008	43
District of Columbia		70	100
Florida		1,821	3
Georgia	250	17,337	29
Idaho	2,198	18,198	21
Illinois	1,136	10,082	18
Indiana		2,941	8
Iowa	182	10,448	19
Kansas		64,159	78
Kentucky	329	16,476	41
Louisiana	330	8,283	17
Maine	402	7,801	24
Maryland	321	10,771	88
Massachusetts		8,266	100
Michigan	439	4,924	8
Minnesota	495	3,582	4
Mississippi	47	1,796	4
Missouri	320	34,692	50
Montana	3,351	52,648	36
Nebraska		25,974	34
Nevada	1,772	50,475	46
New Hampshire	4	3,380	36
New Jersey		8,224	100
New Mexico	1,733	31,907	26
New York	649	40,221	81
North Carolina	243	17,661	34
North Dakota	741	9,716	14
Ohio	2,022	27,319	67
Oklahoma		38,677	55
Oregon	605	18,279	19
Pennsylvania	629	22,813	50
Rhode Island		1,248	100
South Carolina		5,640	18
South Dakota		17,956	23
Tennessee		20,345	48
Texas	493	66,807	25
Utah	373	67,425	79
Vermont		3,537	37
Virginia		29,980	70
Washington	2,228	20,754	30
West Virginia		24,120	99.8
Wisconsin		11,789	21
Wyoming	2,123	26,026	27
	32,808	1,107,765	

ATLANTIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Alabama, Georgia, Louisiana, Maine, Maryland, Mississippi, New York, North Carolina, Pennsylvania, Tennessee, Virginia, and West Virginia. This work comprised the survey of 14 quadrangles and the resurvey or revision of 6 quadrangles. In addition, 18 quadrangles were partly surveyed, 5 were partly resurveyed, and large-scale traverse surveys were made of 2 counties and 1 district. The total new area mapped was 2,905 square miles—2,545 for publication on the scale of 1:62,500 and 360 for publication on the scale of 1:24,000. The area resurveyed was 1,941 square miles—633 for publication on the scale of 1:125,000 and 1,308 for publication on the scale of 1:62,500. In connection with this work, 994 miles of primary levels were run and 268 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by five parties, the work being distributed over portions of Louisiana, Maine, Maryland, North Carolina, and West Virginia. The total area covered by the primary control was about 2,500 square miles, of which 1,350 were controlled by primary traverse, 537 miles being run and 115 permanent marks set. Eighteen triangulation stations were occupied and 11 were marked. The result of this work was to make control available in six 15-minute quadrangles and one irregular area.

Topographic surveys in Atlantic division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.		Primary traverse.	
		1:125,000.	1:62,500.						
		Resurvey.	New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Alabama	50			250	250	64	20		
Georgia	20		250		250	71	15		
Louisiana	5				[a] 360	284	62	467	110
Maine	20		402		402	46	12		
Maryland	20		321		321				
Mississippi	20		47		47	70	12		
New Hampshire	20		4		4				
New York	20		649		649	56	17		
North Carolina	20, 100	66	243		309	132	44	70	5
Pennsylvania	20		629		629	78	36		
Tennessee	20, 100	142		66	208				
Virginia	50, 100	425		35	460	96	21		
West Virginia	50			957	957	97	29		
		633	2,545	1,308	4,846	994	268	537	115

[a] 360 square miles in Louisiana for publication on the scale of 1:24,000.

DETAILS OF WORK BY STATES.

Alabama.—The resurvey of the southeast quarter of the Bessemer 30-minute quadrangle, constituting the Columbiana quadrangle, in Shelby and Chilton counties, Ala., was completed by W. J. Lloyd, F. E. Hale, jr., C. K. Alexander, and F. L. Kendig, the total area mapped being 250 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area William Oram ran 64 miles of primary levels and established 20 permanent bench marks.

Georgia.—The survey of the Milledgeville quadrangle, in Baldwin and Hancock counties, Ga., was completed by Oscar Jones, J. I. Gayetty, and L. K. Rushing, the total area mapped being 250 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area F. W. Farnsworth ran 71 miles of primary levels and established 15 permanent bench marks.

Louisiana.—Work was continued under the allotment of $20,000 made by the president of the board of commissioners of the fifth Louisiana levee district for the beginning of cooperative topographic surveys in the Tensas basin, $6,700 being allotted by the United States Geological Survey. The survey of the Mound and Lake Providence quadrangles and parts of the Millikens Bend, Tallulah, Delta Bridge, Baxter Bayou, Millikin, Ashton Bridge, Vidalia, Lake Bruen, Sycamore Landing, Wilson Point, Delta Point, and Longwood quadrangles was completed, the total area mapped being 360 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. This work was done by W. N. Vance, Olinus Smith, H. W. Peabody, L. L. Lee, J. M. Rawls, R. A. Kiger, and E. V. Perkinson and is included in portions of Madison, East and West Carroll, Tensas, and Concordia parishes. For the control of these areas W. H. Gray and T. A. Green ran 284 miles of primary levels, in connection with which 62 permanent bench marks were set, and C. B. Kendall ran 467 miles of primary traverse and set 110 permanent marks.

Maine.—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted $3,500 and the United States Geological Survey allotted a like sum. The survey of the Fryeburg quadrangle, in Cumberland and Oxford counties, and the Kezar Falls quadrangle, in Oxford, York, and Cumberland counties, Me., and Carroll County, N. H., was completed, and that of the Livermore quadrangle, in Androscoggin and Kennebec counties, was begun by Hersey Munroe, R. H. Reineck, and Charles Hartmann, jr., the total area mapped being 406 square miles, of which 4 square miles was in New Hampshire, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Fryeburg and

Livermore quadrangles E. B. Hillegass and Mr. Hartmann ran 46 miles of primary levels and established 12 permanent bench marks. For the control of the Buckfield, Bethel, and Livermore quadrangles, in Androscoggin, Oxford, and Kennebec counties, E. L. McNair occupied 10 triangulation stations and marked 7. Secondary control for the Waldoboro quadrangle, in Knox and Lincoln counties, was commenced by Ray Purington.

Maryland.—For the continuation of cooperative topographic surveys in Maryland the state geologist allotted $3,000 and the Federal Survey $4,000. The survey of the Taneytown and Emmitsburg quadrangles, in Carroll, Frederick, and Washington counties, Md., and Adams and Franklin counties, Pa., was completed and that of the Hagerstown quadrangle was commenced, the total area mapped being 402 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. Of this area 81 square miles lies in Pennsylvania, and the mapping of that portion was paid for from funds of that State. For the control of the Williamsport quadrangle, in Washington, Franklin, and Berkeley counties, G. T. Hawkins occupied 4 triangulation stations and marked 2. Secondary control on this quadrangle was continued by R. H. Reineck, Jay De Puy, P. W. McMillen, and Olinus Smith.

Mississippi.—The survey of the Iuka quadrangle, in Tishomingo County, Miss., was commenced by C. C. Gardner, the area mapped being 47 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. For the control of this quadrangle William Oram ran 70 miles of primary levels and established 12 permanent bench marks.

New York.—The state engineer and surveyor of New York allotted $7,000 for the continuation of cooperative topographic surveys in the State and the Federal Survey allotted a like sum for the same purpose. The survey of the Delhi and Hartwick quadrangles, in Otsego and Delaware counties, and of the Antwerp and Hammond quadrangles, in Jefferson and St. Lawrence counties, was completed, and that of the Canton quadrangle, in St. Lawrence County, was commenced, the total area mapped being 649 square miles, for publication on the scale of 1: 62,500, with a contour interval of 20 feet. This work was done by R. D. Cummin, C. E. Cooke, R. C. McKinney, W. H. S. Morey, J. R. Haswell, and J. M. Whitman. For the control of the Hartwick quadrangle A. F. McNair ran 56 miles of primary levels and established 17 permanent bench marks. Secondary control for the New Berlin quadrangle, in Chenango and Otsego counties, was completed by L. C. Fletcher.

North Carolina.—The state geologist of North Carolina allotted $2,500 and the Federal Survey a like sum for the continuation of cooperative topographic surveys. A traverse survey of Cleveland

and Franklin counties, on the scale of 1:24,000, was completed by R. L. Harrison, M. W. Gray, and C. S. Wells. In addition to the cooperative work, the survey of the Lincolnton quadrangle, in Lincoln, Gaston, and Cleveland counties, was completed by Mr. Harrison, J. D. Forster, and J. B. Metcalfe, the area mapped being 243 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area G. T. Hawkins ran 70 miles of primary traverse and set 5 permanent marks, and F. P. Hoover ran 132 miles of primary levels and established 44 permanent bench marks. The portion of the Lincolnton quadrangle that lies in Cleveland County was mapped in cooperation with the state geologist.

Pennsylvania.—The Topographic and Geological Survey Commission of Pennsylvania allotted $4,238 for the continuation of the cooperative topographic survey of the State and the United States Geological Survey allotted a like sum for the same purpose. The survey of the Hamburg quadrangle, in Berks, Lehigh, and Carbon counties, and the Franklin quadrangle, in Venango County, was completed, and that of the Hilliards quadrangle, in Butler and Venango counties, and the McCalls Ferry quadrangle, in Lancaster and York counties, was begun, the total area mapped being 548 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by R. C. McKinney, S. P. Floore, R. H. Reineck, R. A. Kiger, W. N. Vance, and Duncan Hannegan. For the control of the McCalls Ferry quadrangle C. H. Semper ran 78 miles of primary levels and established 36 permanent bench marks. (See also Maryland, above.)

Tennessee.—The resurvey of the Pikeville 30-minute quadrangle (Tenn.) was continued by Oscar Jones and J. I. Gayetty and resulted in the completion of the work on the Pikeville special quadrangle, in Bledsoe and Rhea counties, the area mapped being 66 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Tennessee-North Carolina.—J. I. Gayetty continued the revision of the Mount Guyot quadrangle, completing 4 square miles in Haywood County, N. C., and 14 square miles in Cocke and Sevier counties, Tenn., for republication on the scale of 1:125,000, with a contour interval of 100 feet.

Virginia.—For cooperative topographic surveys in Virginia the state geologist and the United States Geological Survey each allotted $1,750. A traverse survey of the Virgilina district, in Halifax, Charlotte, and Mecklenburg counties, was completed by T. Foster Slaughter on the scale of 1:24,000. (See also West Virginia, below.)

Virginia-Tennessee-North Carolina.—The resurvey of the Abingdon quadrangle, in Smyth, Washington, Russell, and Tazewell counties, Va., Sullivan and Johnson counties, Tenn., and Ashe County, N. C., was completed by Duncan Hannegan, R. A. Kiger, H. W. Peabody, J. D. Forster, and C. C. Gardner, the total area mapped being 615 square miles, for publication on the scale of 1: 125,000, with a contour interval of 100 feet. For the control of this area J. B. Metcalfe ran 96 miles of primary levels and established 21 permanent bench marks. Of the area mapped, 425 square miles lies in Virginia, 62 in North Carolina, and 128 in Tennessee.

West Virginia.—For the continuation of cooperative topographic surveys in West Virginia the state geologist allotted $15,000, which was met by a like sum from the Federal Survey. The resurvey of areas previously mapped resulted in the completion of the survey of the Madison and Peytona quadrangles, in Kanawha, Boone, Lincoln, and Logan counties, and the Pocahontas special and Gilbert quadrangles, in Mercer, McDowell, and Wyoming counties, W. Va., and Tazewell County, Va.; and in the completion of parts of the Welch and Pineville quadrangles, in McDowell and Wyoming counties, and the Matewan quadrangle, in Mingo and Logan counties, the total area mapped being 992 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by F. E. Matthes, E. P. Davis, S. E. Taylor, F. O. Leonard, E. I. Ireland, C. S. Wells, A. J. Dailey, C. C. Gardner, J. D. Forster, Fred McLaughlin, Oscar Jones, J. H. Wilson, J. B. Metcalfe, R. A. Ireland, R. H. Kilmer, and J. S. Nurnberger. Of the Pocahontas special quadrangle, 35 square miles lies in Virginia, and the mapping of this portion was paid for from federal funds. For the control of the Gilbert quadrangle T. A. Green and J. H. Wilson ran 56 miles of primary levels and established 16 permanent bench marks, and for the control of the Pineville quadrangle J. B. Metcalfe ran 41 miles of primary levels and established 13 permanent bench marks. For the control of the Warfield quadrangle, in Mingo and Wayne counties, R. C. Seitz occupied 4 triangulation stations and marked 2.

OFFICE WORK.

The drafting of the following sheets was completed: Columbiana, Ala.; Milledgeville, Ga.; Ellsworth, Me.; Fryeburg, Me.-N. H.; Neversink, Antwerp, Monticello, and Delhi, N. Y.; Lincolnton, N. C.; Emmitsburg and Taneytown, Md.-Pa.; Hamburg, Franklin, and Butler, Pa.; Mound and Lake Providence, La.; Pikeville special, Tenn.; Abingdon, Va.-N. C.-Tenn.; Pocahontas special, Va.-W. Va.; and Peytona, Madison, and Gilbert, W. Va.

Progress in the drafting of additional sheets was made as follows: Millikens Bend, Tallulah, and Delta Bridge, La., 80 per cent; Baxter Bayou, La., 66 per cent; Millikin, La., 50 per cent; Ashton Bridge, La., 35 per cent; Vidalia, La., 40 per cent; Lake Bruen, La., 30 per cent; Sycamore Landing, Wilson Point, and Delta Point, La., 20 per cent; Longwood, La., 5 per cent; Kezar Falls, Me., 50 per cent;

Hartwick, N. Y., 70 per cent; Hammond, N. Y., 65 per cent; Mount Guyot, Tenn., 60 per cent; Matewan, W. Va., 66 per cent; Welch, W. Va., 25 per cent; Williamson and Pineville, W. Va., 10 per cent.

In the triangulation and computing section the following computations were made:

Primary level circuits in the Columbiana quadrangle (Ala.) were adjusted.

Primary level circuits in the Milledgeville quadrangle (Ga.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the area embraced by the Tensas drainage district (La.).

Primary level circuits run by the water-resources branch of the Survey along the east and west forks of Penobscot River, in Penobscot and Piscataquis counties, Me., and level circuits in the Bethel, Fryeburg, Kezar Falls, and Rumford quadrangles (Me.) were adjusted.

Latitudes, departures, and geographic positions in the Hagerstown quadrangle (Md.-Pa.) and geodetic positions and distances in the Williamsport quadrangle (Md.-W. Va.-Pa.) were computed.

Primary level circuits in the Iuka quadrangle (Miss.-Ala.-Tenn.) were adjusted.

Primary level circuits in the Bath and New Berlin quadrangles (N. Y.) were adjusted.

Precise level circuits in the Greensboro quadrangle (N. C.) and primary level circuits in the Lincolnton quadrangle (N. C.) were adjusted. Latitudes, departures, and geographic positions in the Lincolnton quadrangle were computed.

Primary level circuits in the Pikeville quadrangle (Tenn.) were adjusted.

Precise level circuits in the Covington quadrangle (Va.-W. Va.) and primary level circuits in the Abingdon quadrangle (Va.-N. C.-Tenn.) were adjusted.

Distances and positions in the Bald Knob, Eccles, Mullen, Pineville, and Wayne (W. Va.), Iaeger, Oceana, and Welch (Va.-W. Va.), and Gilbert and Matewan (W. Va.-Va.-Ky.) quadrangles were computed. Primary level circuits in the Iaeger, Pocahontas, and Welch (W. Va.-Va.) and Gilbert and Matewan (W. Va.-Va.-Ky.) quadrangles were adjusted.

Level lists covering the work done in the areas embraced by the following groups of States were assembled, computations and readjustments being made where necessary, and sent to the editor for publication as bulletins, with the exception of the last group, which is not yet completed: Alabama, Georgia, North Carolina, South Carolina, and Tennessee (Bulletin 441); Maine, New Hampshire, and Vermont (Bulletin 437); Delaware, District of Columbia, Maryland, and Virginia (Bulletin 434); and Arkansas, Louisiana, and Mississippi.

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Illinois, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, and Ohio. The work comprised the survey of 20 quadrangles and 1 special area and the resurvey of 1 special area. In addition, 7 quadrangles, 1 special area, and 2 river projects were partly surveyed. The total new area mapped was 4,923 square miles—4,656 for publication on the scale of 1:62,500 and 267 for publication on the scale of 1:24,000. The area resurveyed was 14 square miles, for publication on the scale of 1:24,000. In connection with this work 1,673 miles of primary levels were run and 424 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by five parties, the work being distributed over portions of Illinois, Kentucky, Minnesota, Missouri, and Ohio. The total area covered by this primary control was about 9,600 square miles, of which 6,800 were controlled by primary traverse, 1,469 miles being run and 132 permanent marks set. Seventy triangulation stations were occupied, 58 were marked, and 110 were intersected. The result of this work was to make control available in thirty-six 15-minute quadrangles and two river projects.

Topographic surveys in Central division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.		Primary traverse.	
		1:62,500.	1:24,000.			Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	New.	Resurvey.					
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Illinois	5, 20	1,034	102	....	1,136	432	97	347	30
Iowa	20	182	....	....	182	90	20	....	....
Kansas	20	....	....	14	14	....	....	....	....
Kentucky	20	329	....	....	329	127	38	....	....
Michigan	20	274	165	....	439	46	12	74	6
Minnesota	10	495	....	....	495	281	112	....	....
Missouri	10, 20	320	....	....	320	123	24	126	16
Ohio	20	2,022	....	....	2,022	574	121	922	80
		4,656	267	14	4,937	1,673	424	1,469	132

DETAILS OF WORK BY STATES.

Illinois.—The governor of Illinois allotted $17,500 for the continuation of cooperative topographic surveys in the State and the United States Geological Survey allotted $12,500 for the same purpose. The survey of Apple River and the Illinois portion of the Galena quadrangle, in Jo Daviess County; the Hennepin and Lasalle quadrangles, in Bureau, Putnam, and Lasalle counties; and the New Athens quadrangle, in St. Clair and Monroe counties, was completed, the total area mapped being 1,034 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by J. H. Renshawe, Frank Tweedy, A. M. Walker, J. F. McBeth, R. T. Evans, B. A. Jenkins, J. De Puy, and G. R. Hoffman. The survey of the Embarrass River project, in Jasper, Crawford, and Lawrence counties, was begun by L. L. Lee and H. W. Peabody, and that of the Spoon River project, in Fulton County, by C. C. Gardner. The total area mapped was 102 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet, and for its control C. B. Kendall ran 293 miles of primary traverse and set 27 permanent marks, and Mr. Peabody and S. R. Archer ran 79 miles of primary levels and set 6 permanent bench marks. For the control of the Lincoln quadrangle, in Logan County, and the Canton, Havana, Macomb, Vermont, Colchester, Carthage, and Keokuk quadrangles, in Fulton, Hancock, McDonough, and Schuyler counties, E. M. Bandli ran 263 miles of primary levels and established 70 permanent bench marks. For the control of the Milan quadrangle, in Rock Island and Mercer counties, G. E. Heebink ran 90 miles of primary levels and established 21 permanent bench marks. For the control of the Kimswick and Waterloo quadrangles, in Monroe and St. Clair counties, J. R. Ellis ran 54 miles of primary traverse and set 3 permanent marks. Secondary control for the Lincoln quadrangle, in Logan County; the Bridgeport quadrangle, in Lawrence, Edwards, Richland, and Wabash counties; and the Crystal City and Renault quadrangles, in Monroe and Randolph counties, was begun by R. C. Seitz.

Iowa.—The state geologist of Iowa allotted $1,750 for cooperative topographic surveys in Iowa and the Federal Survey allotted a like sum for the same purpose. The survey of the Knoxville quadrangle, in Marion County, and parts of the Pella quadrangle, in Marion and Mahaska counties, was completed by M. Hackett, the total area mapped being 182 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Pella quadrangle, G. E. Heebink ran 90 miles of primary levels, in connection with which 20 permanent bench marks were established.

Kansas.—The resurvey of the Fort Leavenworth quadrangle, in Jefferson, Atchison, and Leavenworth counties, Kans., was completed by J. G. Staack and E. L. Hain, the total area mapped being 14 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet.

Kentucky.—For the continuation of cooperative topographic surveys within Kentucky, the state geologist allotted $5,000 and the Federal Survey allotted a like sum. The survey of the Dawson

Springs quadrangle, in Hopkins, Christian, and Caldwell counties, was completed by C. L. Sadler and F. B. Barrett, and that of the Monticello quadrangle, in Wayne, Russell, and Pulaski counties, was commenced by J. F. McBeth, the total area mapped being 258 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Dawson Springs quadrangle S. R. Archer ran 68 miles of primary levels and established 21 permanent bench marks. For the control of the Laynesville and Inez quadrangles, in Pike, Floyd, Martin, Lawrence, and Johnson counties, and the Ewing, Soldier, Rectorville, Flemingsburg, and Mount Sterling quadrangles, in Fleming, Nicholas, Bath, Lewis, Rowan, Mason, and Montgomery counties, E. L. McNair and R. C. Seitz occupied 25 triangulation stations and marked 21. For the control of the Paintsville quadrangle, in Johnson, Lawrence, Morgan, and Magoffin counties, and the Inez and Louisa quadrangles, Mr. Archer ran 59 miles of primary levels and established 17 permanent bench marks. In addition to the cooperative work, the survey of the Kentucky portion of the Kosmosdale quadrangle, in Jefferson and Bullitt counties, was completed by C. D. S. Clarkson, the total area mapped being 71 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

Michigan.—For the continuation of cooperative topographic surveys in Michigan the state geologist and the United States Geological Survey each allotted $2,000. The survey of the Mason quadrangle, in Ingham County, was completed, and that of the Lansing quadrangle, in Ingham and Eaton counties, was commenced by C. D. S. Clarkson, the total area mapped being 274 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Lansing quadrangle J. R. Ellis ran 74 miles of primary traverse and set 6 permanent marks and L. D. Townsend ran 46 miles of primary levels and set 12 permanent bench marks. In addition to the cooperative work, the survey of the Calumet special quadrangle, in Keweenaw and Houghton counties, was completed by A. M. Walker, the area mapped being 165 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet.

Minnesota.—Work was continued in Minnesota under the allotment of $10,000 made by the state drainage engineer, which was met by an allotment of $5,000 by the Federal Survey. The survey of the Barrett and Herman quadrangles, in Grant, Douglas, and Stevens counties, was completed, and that of the Morris quadrangle, in the same counties, was commenced, the total area mapped being 495 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. This work was done by J. G. Staack, O. H. Nelson, E. L. Hain, W. B. Newhall, and C. S. Stewart. For the control of this area, as well as for the Chokio, Ashby, and Wendell quadrangles, in the same counties, E. M. Douglas and C. S. Stewart occupied 45 triangulation stations, marked 37, and located 110 secondary points and three-point stations, and C. R. Beckler and G. E. Halstead ran 281 miles of primary levels and established 112 permanent bench marks, secondary control being run by R. C. Seitz.

Missouri.—For the continuation of cooperative topographic surveys in Missouri the state geologist and the United States Geological Survey each allotted $4,500. The survey of the Rolla quadrangle, in Phelps and Dent counties, was completed, and that of the Aurora special quadrangle, in Lawrence, Jasper, and Newton counties, was commenced by H. H. Hodgeson, F. W. Hughes, C. H. Swift, and Paul Robins, the total area mapped being 320 square miles, for publication on the scale of 1:62,500, with contour intervals of 20 and 10 feet, respectively. For the control of the Rolla quadrangle Mr. Swift ran 17 miles of primary levels and established 4 permanent bench marks, and for the control of the Aurora special area J. R. Ellis ran 126 miles of primary traverse and set 16 permanent marks and G. P. Featherstone ran 106 miles of primary levels and established 20 permanent bench marks.

Ohio.—The governor of Ohio allotted $15,000 for the continuation of the cooperative topographic survey of the State and a like sum was set apart for the same purpose by the United States Geological Survey. The survey of the Delphos, Spencerville, Loramie, and Covington quadrangles, in Van Wert, Allen, Putnam, Auglaize, Shelby, Miami, and Darke counties, and the Cumberland, Caldwell, Summerfield, Uhrichsville, Canal Dover, and Antrim quadrangles, in Noble, Guernsey, Muskingum, Washington, Morgan, Monroe, Tuscarawas, Harrison, Carroll, Coshocton, Holmes, and Stark counties, was completed, and that of the Laurelville quadrangle, in Vinton, Hocking, Ross, and Pickaway counties, and the Carrollton quadrangle, in Carroll, Stark, and Columbiana counties, was commenced, the total area mapped being 2,022 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by J. H. Jennings, C. W. Goodlove, O. H. Nelson, M. Hackett, H. P. Hancock, L. R. Ebert, H. R. Sargent, J. A. Duck, Charles Hartmann, jr., Fred Graff, jr., and Horace Rayner. For the control of these areas 461 miles of primary levels were run and 95 permanent bench marks were established by C. L. Beckler, H. B. Hoel, N. E. Ballmer, and C. B. Mincks. For the control of the New Comerstown, Millersburg, and Navarre quadrangles, in Tuscarawas, Coshocton, Holmes, Wayne, and Stark counties, E. C. Bibbee and C. B. Mincks ran 60 miles of primary levels and established 10 permanent bench marks. For the control of the Jackson quadrangle, in Jackson and Vinton counties, C. B. Shaw and C. E. Mills ran 53 miles of primary levels and established 16 permanent bench marks. For the control of the Lebanon, Waynesville, Xenia, Sabina, Jeffersonville, Greenfield, Roxabel, Bainbridge, Era, Piketon, Batavia, Hillsboro, Lynchburg, Circleville, and Millersburg quadrangles, in Warren, Green, Clinton, Fayette, Highland, Ross, Pike, Adams, Pickaway, Clermont, Brown, Fairfield, Holmes, and Wayne counties, and the Scioto, Oak Hill, Jackson, Greenup, Otway, Peebles, Portsmouth, West Union, Vanceburg, Manchester, Georgetown, and Bethel quadrangles, in Scioto, Jackson, Lawrence, Adams, Brown, and Clermont counties, J. R. Ellis ran 922 miles of primary traverse and established 80 permanent marks.

OFFICE WORK.

The drafting of the following sheets was completed: Knoxville, Iowa; Hennepin, Stockton, New Athens, La Salle, Ill.; Leavenworth special, Kans.-Mo.; Dawson Springs, Ky.; Mason and Calumet special, Mich.; Herman and Barrett, Minn.; Cumberland, Antrim, Oxford, Caldwell, Summerfield, Covington, Uhrichsville, Delphos, Spencerville, Loramie, and Cambridge, Ohio; Rolla, Mo.

Progress in the drafting of additional sheets was made as follows: Easton, Kans., 50 per cent; Monticello, Kosmosdale, and Prospect, Ky., 50 per cent; Pella, Iowa, 50 per cent; Galena, Ill.-Iowa, 80 per cent; DeQueen, Ark., 40 per cent; Aurora special, Mo., 50 per cent; Lansing, Mich., 25 per cent; Canal Dover, Ohio, 75 per cent.

The following sheets were completely adjusted: Carrolton, Ohio; Lansing, Mich.; and Bridgeport, Ill.

In the triangulation and computing section the following computations were made:

Latitudes, departures, and geographic positions were computed in the Eaton, Lincoln, Rosehill, Sparta, and Waterloo (Ill.) and Crystal City, Kimmswick, and Renault (Ill.-Mo.) quadrangles. Primary level circuits in the Canton, Havana, Lincoln, and Milan quadrangles (Ill.) were adjusted.

Latitudes, departures, and geographic positions in the Vincennes quadrangle (Ind.-Ill.) were computed.

Primary level circuits in the Easton quadrangle (Kans.) were adjusted.

Latitudes, departures, and geographic positions were computed in the Horsebranch, Morgantown, and Rochester quadrangles (Ky.). Geodetic positions and distances in the Ewing, Flemingsburg, Hazard, Laynesville, Mount Sterling, Soldier, and Williamson (Ky.), Inez, Warfield, and Whitesburg (Ky.-W. Va.), and Vanceburg (Ky.-Ohio) quadrangles were computed. Primary level circuits in the Dawson Springs and White Plains quadrangles (Ky.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Lansing quadrangle (*Mich.*).

Primary level circuits in the area embraced by the Red Lake district and in the Barrett, Herman, Morris, and Wendell quadrangles (Minn.) were adjusted. Geodetic distances and positions in the Ashby, Barrett, Chokio, Herman, Morris, and Wendell quadrangles (Minn.) were computed.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Aurora special quadrangle (Mo.). Primary level circuits in the Rolla quadrangle (Mo.) were adjusted.

Latitudes, departures, and geographic positions were computed in the Bainbridge, Batavia, Blanchester, Chillicothe, Circleville, Era, Georgetown, Greenfield, Hillsboro, Jackson, Jeffersonville, Lebanon, Lynchburg, Mason, Mount Sterling, Oak Hill, Octa, Otway, Peebles, Piketon, Portsmouth, Roxabell, Sabina, Springfield, Waynesville, West Union, and Xenia (Ohio) and East Cincinnati, Greenup, and Scioto (Ohio-Ky.) quadrangles. Primary level circuits in the Brinkhaven, Canal Dover, Carrollton, Coshocton, Covington, Delphos, Loramie, Millersburg, New Comerstown, Spencerville, and Uhrichsville quadrangles (Ohio) were adjusted.

Primary level circuits in the Marathon, Waterloo, and Wausau quadrangles (Wis.) were adjusted.

Level lists covering the work done in Illinois (Bulletin 421) and Ohio (Bulletin 411) were published.

ROCKY MOUNTAIN DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Colorado, Montana, New Mexico, North Dakota, Oklahoma, Texas, and Wyoming. This work comprised the survey of 16 quadrangles and 1 national forest and the revision of 2 quadrangles. In addition, 1 national forest was partly surveyed. The total new area mapped was 9,504 square miles—2,766 for publication on the scale of 1:250,000, 6,245 for publication on the scale of 1:125,000, and 493 for publication on the scale of 1:31,680. The area resurveyed was 921 square miles, for publication on the scale of 1:125,000. In connection with this work, 1,389 miles of primary levels were run and 422 permanent bench marks were established. Profile surveys of 2 rivers were also made, the distance traversed being 157 miles.

Primary triangulation and primary traverse were carried on at different times by five parties, the work being distributed over portions of Colorado, New Mexico, and Texas. The total area covered by this primary control was about 4,800 square miles, of which 1,800 were controlled by primary traverse, 684 miles being run and 204 permanent marks set. Twenty-two triangulation stations were occupied and 31 marked. The result of this work was to make control available in one 30-minute quadrangle, one national forest, and three river projects.

Topographic surveys in Rocky Mountain division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.		Primary traverse.	
		1:250,000.	1:125,000.			Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	New.	Resurvey.					
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Colorado	100		1,221		[a] 1,221	180	44		
Idaho	100		86		86				
Montana	20, 100, 200	650	2,615		[b] 3,265	140	38		
New Mexico	100, 200	885	848		1,733	158	42		
North Dakota	50		741		741	29	10		
Oklahoma	50			921	921				
Texas	5				[c] 493	612	224	684	204
Wyoming	100, 200	1,231	734		1,965	270	64		
		2,766	6,245	921	10,425	1,389	422	684	204

[a] 105 square miles mapped by Reclamation Service and published on scale of 1:125,000.
[b] 944 square miles mapped by General Land Office and published on scale of 1:125,000.
[c] 493 square miles in Texas for publication on scale of 1:31,680.

DETAILS OF WORK BY STATES.

Colorado.—The survey of the Mount Jackson quadrangle, in the Holy Cross National Forest, in Eagle, Pitkin, Gunnison, and Chaffee counties, and the Montrose quadrangle, in Montrose, Gunnison, Ouray, and San Miguel counties, Colo., was completed by Gilbert Young, E. R. Bartlett, S. T. Penick, J. A. Burriss, W. M. Kent, and Stanley Hargen. The work on the Aspen 15-minute quadrangle, which is included in the Mount Jackson quadrangle, was revised by E. I. Ireland, and that on the Ouray 15-minute quadrangle, which is included in the Montrose quadrangle, was revised by E. R. Bartlett, as well as 105 square miles of Reclamation Service surveys. The total new area mapped was 1,116 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Montrose quadrangle Mr. Young occupied and marked 6 triangulation stations and for the control of both the Montrose and the Mount Jackson quadrangles F. J. McMaugh ran 180 miles of primary levels and established 44 permanent bench marks. A profile survey of Gunnison River, in Gunnison, Summit, and Grand counties, was made by Stanley Hargen, the total distance traversed being 120 miles.

Montana.—The survey of the Thibideau Lake and Zurich quadrangles, in Chouteau County, Mont., was completed by W. L. Miller, Basil Duke, and G. W. Lucas, the total area mapped being 769 square miles, the southern half of these quadrangles having been previously mapped for publication on the scale of 1:62,500. For the control of these areas W. R. Winstead ran 93 miles of primary levels and established 25 permanent bench marks. The survey of the Cutbank and Blackfoot quadrangles, in Teton County, was completed by R. W. Berry, H. G. Parry, and Conrad Ecklund, the total area surveyed being 634 square miles. The remainder of these quadrangles, consisting of 944 square miles, is included within the Blackfeet Indian Reservation, already topographically mapped by the General Land Office, in connection with its subdivision surveys, the results of which were incorporated in the maps. All of the above work was for publication on the scale of 1:125,000, with a contour interval of 20 feet. For the control of the Cutbank quadrangle Mr. Parry ran 47 miles of primary levels and established 13 permanent bench marks. A profile survey of Judith River, in Fergus County, was made by C. A. Leonard, the total distance traversed being 37 miles.

Montana-Idaho.—The survey of the Missoula quadrangle, in the Lolo National Forest, in Missoula, Ravalli, Flathead, and Clearwater counties, Mont., and Idaho County, Idaho, was completed by Lee Morrison and W. J. Forster, the area mapped being 354 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet; 86 square miles of this area is in Idaho.

New Mexico.—The survey of the Mogollon quadrangle, in Grant and Socorro counties, N. Mex., was completed by A. B. Searle, A. P. Meade, jr., and R. S. Van Atta, the total area mapped being 848 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of parts of the Alamo National Forest, in Otero, Chaves, and Lincoln counties, was completed by V. H. Manning, J. H. Wilke, and K. W. Trimble, the area mapped being 885 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. For the control of this forest R. B. Robertson occupied 16 triangulation stations and marked 25, and Mr. Trimble ran 158 miles of primary levels and established 42 permanent bench marks.

North Dakota.—The survey of the Ray quadrangle, in Williams and McKenzie counties, N. Dak., was completed by G. S. Smith, J. H. Van Wagenen, Conrad Ecklund, Chester Irvine, and C. A. Leonard, the total area mapped being 741 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area Messrs. Van Wagenen and Leonard ran 29 miles of primary levels and established 10 permanent bench marks.

Oklahoma.—The revision of the culture on the Sanbois and Sallisaw quadrangles, in Sequoyah, Haskell, Latimer, Pittsburg, Muskogee, and LeFlore counties, Okla., was completed by C. P. Janerson, D. B. Penick, and C. J. Ballinger, the total area revised being 921 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

Texas.—The governor of Texas allotted $20,000 for the initiation of cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum for the same purpose. Work was begun in the Brazos and Little River valleys, and also in the valley of the East Fork of Trinity River. The survey of the Howth, Courtney, and Navasota quadrangles, in Burleson, Brazos, Grimes, and Washington counties, the Buckholtz quadrangle, in Milan County, and the Rockwall and Barnesbridge quadrangles, in Rockwall, Kaufman, and Collin counties, was completed, the total area mapped being 493 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. This work was done by Gilbert Young, T. F. Slaughter, S. P. Floore, A. P. Meade, B. A. Jenkins, Charles Hartmann, jr., Fred Graff, jr., R. T. Evans, and S. T. Penick. For the control of these areas F. J. McMaugh, P. W. McMillen, and E. L. McNair ran 684 miles of primary traverse and set 204 permanent marks; C. H. Semper, F. H. West, P. W. McMillen, F. Hurst, and E. L. McNair ran 612 miles of primary levels, in connection with which 224 permanent bench marks were established.

Wyoming.—The survey of the Sheridan quadrangle, in Sheridan and Johnson counties, Wyo., was completed by C. E. Cooke, F. H. West, C. A. Leonard, P. W. McMillen, and H. W. Parry, the area mapped being 734 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area F. H. West and C. F. Fisher ran 98 miles of primary levels and established 19 permanent bench marks.

Wyoming-Montana.—The survey of the Shoshone National Forest, in Bighorn County, Wyo., and Carbon, Sweet Grass, and Park counties, Mont., was completed by E. I. Ireland, the area mapped being 650 square miles in Montana and 1,231 square miles in Wyoming, for publication on the scale of 1:250,000, with a contour interval of 200 feet. For the control of this forest Orr Meredith ran 172 miles of primary levels and established 45 permanent bench marks.

OFFICE WORK.

The drafting of the following sheets was completed: Montrose and Mount Jackson, Colo.; Zurich, Thibideau Lake, Blackfoot, Cutbank, and Bear Tooth National Forest, Mont.; Missoula, Mont.-Idaho; Ray, N. Dak.; Sanbois and Sallisaw, Okla.; Sheridan and Shoshone National Forest, Wyo.; Barnesbridge, Rockwall, Howth, Courtney, Navasota, and Buckholtz, Tex.

Progress in the drafting of additional sheets was made as follows: Mogollon, N. Mex., 95 per cent; Alamo National Forest, N. Mex., 75 per cent.

In the triangulation and computing section the following computations were made:

Primary level circuits in the Carbondale, Glenwood Springs, Leadville, Montrose, Mount Jackson, San Cristobal, and Uncompahgre quadrangles (Colo.) were adjusted.

Primary level circuits in the Brocton, Browning, Cutbank, Nashua, Pacific Junction, Plentywood, Poplar, Scobey, Wolf Point, and Zurich (Mont.) and Missoula (Mont.-Idaho) quadrangles were adjusted.

Primary level circuits in the Magdalena quadrangle (N. Mex.) were adjusted and geodetic distances and positions in the Alamogordo quadrangle (N. Mex.) were computed.

Primary level circuits in the Ray quadrangle (N. Dak.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed in the Brazos River, Little River, and Trinity River basins (Tex.).

Primary level circuits in the Shoshone National Forest (Wyo.) were adjusted.

Level lists were revised for the States of Colorado, Oklahoma, Montana, Wyoming, Texas, Utah, Nebraska, and South Dakota.

PACIFIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, and Wyomingl This work comprised the survey of 27 quadrangles and 1 nationa. park and the revision of 1 special area. In addition, 15 quadrangles, 3 national forests, and 2 special areas were partly surveyed. The total new area mapped was 15,476 square miles—9,433 for publication on the scale of 1:250,000, 4,793 for publication on the scale of 1:125,000, 1,215 for publication on the scale of 1:62,500, and 35 for publication on the scale of 1:45,000. The area resurveyed was 855 square miles—847 for publication on the scale of 1:31,680 and 8 for publication on the scale of 1:30,000. In connection with this work, 1,210 miles of primary levels were run and 284 permanent bench marks were established. In addition, profile surveys of 3 rivers were made, the distance traversed being 417 miles.

Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of California, Oregon, Nevada, and Washington. The total area covered by this primary control was about 6,500 square miles, of which 797 were controlled by primary traverse, 72 miles being run and 3 permanent marks set; 46 triangulation stations were occupied, 24 were marked, and 31 were intersected. The result of this work was to make control available in eighteen 7½-minute quadrangles, two 30-minute quadrangles, one 1-degree quadrangle, and one national park.

Topographic surveys in Pacific division from July 1, 1909, to June 30, 1910.

State.	Contour interval.	For publication on scale of—			Total area surveyed.	Levels.		Primary traverse.	
		1:250,000 (new).	1:125,000 (new).	1:62,500 (new).		Distance run.	Bench marks.	Distance run.	Permanent marks.
	Feet.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Miles.*		*Miles.*	
Arizona	100		45		45	79	20		
California	5, 50, 100, 200	6,432	1,637	114	[a]9,030	466	112		
Idaho	100, 200	565	1,489	58	2,112	186	30		
Nevada	50, 100	1,691	81		[b]1,780	11	3		
Oregon	7, 50, 100		299	306	605	123	22		
Utah	50, 100		338		[c]373	88	23		
Washington	25, 50, 200	745	746	737	2,228	257	74	72	3
Wyoming	50, 100		158		158				
		9,433	4,793	1,215	16,331	1,210	284	72	3

[a] 847 square miles resurvey in California for publication on scale of 1:31,680.
[b] 8 square miles resurvey in Nevada for publication on scale of 1:30,000.
[c] 35 square miles in Utah for publication on scale of 1:45,000.

DETAILS OF WORK BY STATES.

Arizona.—The survey of the Winkleman quadrangle, in Pinal County, Ariz., was commenced by J. E. Blackburn and S. G. Lunde, the total area mapped being 45 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this quadrangle L. F. Biggs ran 79 miles of primary levels and established 20 permanent bench marks.

California.—The Department of Engineering of California allotted $14,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted a like sum for the same purpose. In the Sacramento Valley the resurvey of the Marysville and Smartsville quadrangles, in Yuba, Sutter, Colusa, Butte, Glenn, and Tehama counties, was continued and resulted in the mapping of the Browns Valley, Yuba City, Grimes, Butte City, Reeds, Honcut, Lomo, Sutter City, Gridley, Meridian, French Crossing, Palermo, Butte Creek, and Biggs quadrangles and parts of the Smartsville, Nelson, Oroville, Eddys, Marysville Buttes, and Pennington quadrangles, the total area mapped being 847 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The mapping of the Salinas quadrangle, in Monterey County, was also commenced, the area completed being 114 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by W. H. Griffin, W. B. Lewis, J. P. Harrison, T. H. Moncure, A. T. Fowler, Robert Muldrow, M. A. Knock, Bayard Knock, W. H. Barringer, A. J. Ogle, J. L. Lewis, and E. R. Bartlett. For the control of the above-named areas and the Soledad quadrangle 36 triangulation stations were occupied, 16 were marked, and 26 points were intersected by C. F. Urquhart. For the control of the Sacramento Valley areas mentioned above and also for the Dry Creek, Newhard, Dayton, Durham, Clear Creek, Keefers, and Nord quadrangles, as well as for the Soledad quadrangle, L. F. Biggs ran 174 miles of primary levels and established 39 permanent bench marks. In addition to the cooperative work in California, the survey of the Mount Goddard quadrangle, which lies partly in the Sierra National Forest, in Fresno and Mono counties, was completed by G. R. Davis, and that of the Mariposa quadrangle, in Mariposa, Fresno, and Madera counties, was continued by C. H. Birdseye, T. P. Pendleton, and A. J. Ogle, the total area mapped being 622 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Big Bar quadrangle and adjacent territory, in the Trinity National Forest, in Trinity County, was continued by J. P. Harrison, the area mapped being 497 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the oil belt, in Stanislaus and San Joaquin counties, and that of the McKittrick quadrangle, in Kern, San Luis Obispo, and Santa Barbara counties, was completed by R. M. La Follette and T. P. Pendleton, the total area mapped being 423 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For additional control of the Mariposa quadrangle 17 miles of primary levels were run by Sidney Birdseye, and 3 vertical-angle bench marks were established on the Mount Goddard quadrangle by G. R. Davis.

California-Nevada.—The survey of the Bridgeport quadrangle, which lies partly in the Sierra National Forest, in Mono and Tuolumne counties, Cal., and Esmeralda County, Nev., was completed by G. R. Davis, Pearson Chapman, and C. M. Weston, the area mapped being 673 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area, 81 square miles lies in Nevada. For the control of this area Mr. Weston ran 38 miles of primary levels and established 10 permanent bench marks. Five permanent bench marks were also established by vertical angulation. The survey of the Hawthorne quadrangle, in Mono County, Cal., and Esmeralda and Nye counties, Nev., was completed by C. G. Anderson, and that of the Ivanpah quadrangle, in San Bernardino County, Cal., and Lincoln, Inyo, and Clark counties, Nev., was completed by J. E. Blackburn and S. G. Lunde, the total area mapped being 7,626 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. Of this area 1,691 square miles lies in Nevada. For the control of the Ivanpah quadrangle C. F. Urquhart occupied 8 triangulation stations, marked 7, and intersected 5, and L. F. Biggs ran

237 miles of primary levels, in connection with which 55 permanent bench marks were established. For the control of the Hawthorne quadrangle C. M. Weston ran 11 miles of primary levels and established 3 permanent bench marks.

Idaho.—The survey of the Meadows quadrangle, which lies partly in the Weiser National Forest, in Washington and Boise counties, Idaho, was completed by A. O. Burkland and E. A. Lincoln, and that of the Cataldo quadrangle, in the Cœur d'Alene National Forest, in Shoshone, Bonner, and Kootenai counties, was completed by W. O. Tufts, J. W. Muller, and O. G. Taylor, the total area mapped being 766 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of portions of the Kaniksu and Pend Oreille national forests, in Bonner County, was continued by Messrs. Tufts, Muller, and Taylor, the area mapped being 565 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the Wayan quadrangle, which lies partly in the Caribou National Forest, in Bannock and Bear Lake counties, was begun by Albert Pike and W. O. Tufts, the area mapped being 33 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. (See also p. 79.)

Idaho-Wyoming.—The survey of the Montpelier quadrangle, which lies partly within the Bear River and Caribou national forests, in Bear Lake and Bannock counties, Idaho, and Uinta County, Wyo., was completed by A. E. Murlin, Albert Pike, and M. A. Knock, the total area mapped being 781 square miles, of which 91 square miles is in Wyoming, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area L. F. Biggs ran 186 miles of primary levels and set 30 permanent bench marks.

Nevada.—The revision of the culture of the Ely special quadrangle, in White Pine County, Nev., was completed by W. O. Tufts, the area revised being 8 square miles, for republication on the scale of 1:30,000, with a contour interval of 50 feet.

Oregon.—The state engineer of Oregon allotted $2,500 for the continuation of cooperative topographic surveys in that State, which was met by a like sum for the same purpose from the United States Geological Survey. The survey of the Willamette Valley was continued and resulted in the completion of the mapping of parts of the Halsey and Elmira quadrangles, in Lane, Benton, and Linn counties, the total area mapped being 171 square miles, for publication on the scale of 1:62,500, with a contour interval of 7 feet. This work was done by C. A. Clunet, Robert Muldrow, and W. B. Lewis. For the control of these areas L. F. Biggs ran 123 miles of primary levels and established 22 permanent bench marks. In addition to the cooperative work, the survey of the Crater Lake National Park, in Klamath County, was completed by Pearson Chapman, the area mapped being 135 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this park Mr. Chapman occupied 2 triangulation stations and marked 1. A profile survey of Deschutes and John Day rivers, in Wheeler, Wasco, and Crook counties, was made by J. L. Lewis and E. L. Sellon, the length of traverse being 240 miles.

Oregon-Washington.—The survey of the Mount Hood special quadrangle, which lies partly in the Bull Run National Forest, in Multnomah, Clackamas, and Wasco counties, Oreg., and Clarke and Skamania counties, Wash., was continued by R. M. La Follette, E. L. Sellon, and E. R. Johnston, the area mapped being 299 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The entire area mapped was in Oregon.

Utah-Wyoming.—The survey of the Randolph quadrangle, which lies partly in the Bear River National Forest, in Rich and Cache counties, Utah, and Uinta County, Wyo., was continued by Albert Pike, the area mapped being 405 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 67 square miles lies in Wyoming. For the control of this quadrangle L. F. Biggs ran 88 miles of primary levels and established 23 permanent bench marks.

Utah.—The Frisco special quadrangle, in Beaver County, Utah, was enlarged by the mapping of 35 square miles by W. M. Beaman, for publication on the scale of 1:45,000, with a contour interval of 50 feet. A profile survey of Green River, in Uinta and Emery counties, was made by Stanley Hargen, the area traversed being 177 miles.

Washington.—Under the allotment of $10,000 each made by the Board of Geological Survey of Washington and the United States Geological Survey, topographic mapping was continued, and resulted in the completion of the survey of the Quincy, Red Rock, and Winchester quadrangles and part of the Beverly quadrangle, in Grant, Adams, and Douglas counties, for publication on the scale of 1:62,500, with a contour interval of 25 feet; also the completion of the Mount Vernon quadrangle, in Snohomish and Skagit counties, for publication on the scale of 1:125,000, with a contour interval of 50 feet. The total area mapped was 1,425 square miles, the work being done by J. R. Eakin, W. B. Kern, G. V. Brown, W. A. Gelbach, C. F. Eberly, H. L. McDonald, A. O. Burkland, and R. M. La Follette. For the control of these areas W. A. Gelbach and C. H. Semper ran 257 miles of primary levels and established 74 permanent bench marks, and C. A. Clunet ran 72 miles of primary traverse and set 3 permanent bench marks. In addition to the cooperative work, the survey of the Washington National Forest, in Skagit and Whatcom counties, was continued by J. E. Blackburn, the area mapped being 745 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet.

IDAHO-WASHINGTON BOUNDARY LINE.

Work on the Idaho-Washington boundary line was continued under the appropriation of $25,000 made by Congress in 1908 for its survey, the work having been placed in charge of the United States Geological Survey by the Secretary of the Interior. The survey was completed by C. L. Nelson and S. G. Lunde, 42 miles of the line being surveyed and marked by 45 iron monuments 6 feet long, 4 inches in diameter, filled with concrete, and by 2 granite monuments 6 feet long and 10 inches square. In addition to these, 55 iron monuments 4 feet long and 3 inches in diameter, filled with concrete, were placed at the closing corners of the public-land surveys. In connection with this work, the topography of an area one-half mile in width on each side of the line was mapped by Bayard Knock and Mr. Nelson, this area comprising 116 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

OFFICE WORK.

The drafting of the following sheets was completed: Bridgeport, Cal.-Nev.; Mount Goddard, Reeds, Yuba City, Sutter City, Lomo, Arcade, Antelope, Brighton, Mills, Browns Valley, Grimes, Meridian, McKittrick, and Smartsville special, Cal.; Montpelier, Cataldo, and Meadows, Idaho; Crater Lake, Harrisburg, and Rowland, Oreg.; Frisco special, Utah; Mount Vernon, Winchester, Red Rock, and Quincy, Wash.; Idaho-Washington boundary line; Hawthorne, Nev.

Progress in the drafting of additional sheets was made as follows: Eddys, Cal., 75 per cent; Mariposa, Gridley, Honcut, French Crossing, and Salinas, Cal., 66 per cent; Marysville Buttes, Cal., 50 per cent; Big Bar, Cal., 75 per cent; Bangor and Pennington, Cal., 25 per cent; Tracy (oil belt), Cal., 25 per cent; Smartsville, Cal., 40 per cent; Kaniksu and Pend Oreille national forests, Idaho, 35 per cent; Mount Hood special, Oreg., 66 per cent; Elmira and Smithfield, Oreg., 66 per cent; Diamond Hill School, Oreg., 15 per cent; Ivanpah, Cal.-Nev., 50 per cent; Randolph, Utah, 50 per cent; Beverly and Mount Baker, Wash., 50 per cent.

In the triangulation and computing section the following computations were made:

Primary level circuits in the Winkleman quadrangle (Ariz.) were adjusted.

Precise level circuits in the Antioch and Rio Vista quadrangles and primary level circuits in the Bangor, Biggs, Butte City, Grimes, Nelson, Nord, and Oroville (Cal.) and Bridgeport and Ivanpah (Cal.-Nev.) quadrangles were adjusted. Geodetic distances and positions in the Biggs, Butte City, Grimes, Hollister, Metz, Nelson, Nord, Oroville, Salinas, San Lucas, Soledad, and Yuba City (Cal.) and Ivanpah (Cal.-Nev.) quadrangles were computed.

Primary level circuits in the Pocatello and Soda Springs (Idaho) and Montpelier (Idaho-Wyo.) quadrangles were adjusted.

Primary level circuits in the Hawthorne and Ivanpah quadrangles (Nev.-Cal.) were adjusted.

Primary level circuits in the Elmira, Eugene, Halsey, Monroe, and Smithfield quadrangles (Oreg.) were adjusted and geodetic distances and positions were computed in the Albany, Brownsville, Corvallis, Elmira, Halsey, and Monroe quadrangles (Oreg.).

Geodetic distances and positions in the Randolph quadrangle (Utah-Wyo.) were computed.

Primary level circuits in the Bellingham, Beverly, Crater, Ephrata, Kittitas, Malaga, Mount Vernon, Quincy, Red Rock, and Stillaguamish quadrangles (Wash.) were adjusted and latitudes, departures, and geographic positions in the Mount Vernon quadrangle were computed.

Level lists were revised for Arizona, California, and Nevada.

Level lists covering the work done in the State of Washington were assembled, computations and readjustments being made where necessary, preparatory to transmission to the editor for publication as a bulletin.

COMPILATION OF SPECIAL NATIONAL FOREST MAPS.

The work of preparing the folios of the atlas of the national forests was continued under the direction of A. C. Roberts.

The maps were made on the scale of 1 mile to the inch and published with 6 townships to the page. All the work of the United States Geological Survey, the General Land Office, and the Hayden, Transcontinental, and Wheeler surveys, as well as work done by the Forest Service, was incorporated in these maps. The status of all lands inside the forests was furnished by the Forest Service. Where the timber classification was considered up to date, it was shown in color on the maps.

Folios were finished during the fiscal year 1909-10 for the following forests: Datil, Stanislaus, Sierra, Tahoe, Sevier, Santa Barbara, Fish Lake, Powell, Ozark, Inyo, Uinta, Cleveland, Tonto, Alamo, Gila, Prescott, Crook, Modoc, Oregon, Toiyabe, Idaho, Nez Perce, Colville, Ashley, Monterey, Nebo, Deerlodge, Payette, Weiser, Pend Oreille, Cascade, San Luis, Umpqua, Sequoia, Challis, and Kootenai.

The work on the Ocala, Beaverhead, Cabinet, and Deschutes folios was partly completed and they were turned over to the Forest Service by order of the Director.

The folios have been lithographed and delivered to the Forest Service with the exception of the Inyo, Sequoia, and Umpqua, which have been sent to the lithographer.

The Mono and Inyo folios were completed in January, but were partly recompiled from new data finished last season.

The Sierra folio is now undergoing changes from the new data and is practically finished. Seven sheets have been recompiled and sent to the lithographer. The Trinity folio is having the new Big Bar quadrangle added.

INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

As in the past, the field time of the inspectors was divided between regular topographic work and inspection duty. J. H. Renshawe was engaged in the early part of the season in inspection work in the Central and Rocky Mountain divisions, and in the latter part of the season in regular topographic sketching on the Hennepin quadrangle (Ill.). After the completion of the addition to the Frisco special quadrangle (Utah) and its inking in the field, W. M. Beaman spent the balance of the season in inspection work in the Rocky Mountain and Pacific divisions. F. E. Matthes divided his time in the field between topographic work on the Pocahontas special quadrangle (Va.-W. Va.), the instruction of new field men in topographic methods applicable to West Virginia, and inspection in the Atlantic division.

During the office season careful attention was given by Messrs. Renshawe and Beaman to the final drawing of the topographic sheets, with an aim to insuring uniformity of treatment and eliminating personal mannerisms and errors of expression; also to the examination of the finished sheets preparatory to transmission for engraving or photolithographing; to the examination of woodland and land-classification sheets and correction material for the office record; and to the proper transmission of all field-map material within the office. Mr. Matthes's time was devoted to the inking of his field work, to the completion of the report on the Yosemite Valley, and to the revision of the book of instructions for the topographic branch.

INSTRUMENTS AND TOPOGRAPHIC RECORDS.

The minor repairs to instruments were made as heretofore in the Survey shop, much less repair work than usual being given to outside contractors. Two new traverse transits, 102 box compasses of a new style, 6 Beaman alidades, and 4 micrometer alidades were the principal additions to the stock. After considerable investigation, it was decided to adopt an alloy of aluminum bronze (Cu 90 per cent, Al 10 per cent) for bench-mark tablets and for the caps of bench-mark posts.

The addition to the topographic records consisted of 203 triangulation and traverse books, 1,961 level books, 154 vertical-angle or stadia books, and 152 plane-table sheets, all of which were numbered and catalogued.

MAP OF THE UNITED STATES.

The initial point (meridian of Greenwich) in the numbering of the sheets of the 1 : 1,000,000 scale map adopted by this office was changed to the meridian of 180° from Greenwich by the International Geographic Society at a meeting held in London in 1909. The sheets are now numbered from 1 to 60 and proceed eastward around the world.

Of the work begun last year on the 1 : 1,000,000 scale map of the United States, under the direction of A. F. Hassan, the coastal-plain area of North Carolina (sheets I and J 17 and 18), the State of Illinois (portions of sheets J and K 15 and 16), the special Wisconsin area (sheet K 16, latitude 42° to 44°, longitude 87° 30′ to 90°, scale 1 : 250,000), and portions of New Hampshire, Massachusetts, Connecticut, and Rhode Island (sheet K 19) were completed, and the compilation and inking of sheet K 18 was completed, as well as the lettering of the Vermont, New Hampshire, Massachusetts, and Connecticut portions and 18 per cent of the Pennsylvania portion. The submarine contours were compiled for the Florida sheets.

New work included the following:

Sheet L 19, Vermont portion, compiled, inked, and lettered.

Sheet L 18, New York and Vermont portion, compiled, inked, and lettered.

Sheet J 18, Pennsylvania portion, compiled and inked.

Sheet L 16, Michigan portion, compiled, inked, and lettered; Wisconsin portion, compiled and inked; Canadian portion, compiled and inked.

Sheet L 17, Michigan portion, compiled, inked, and lettered.

Sheet M 16 (Canada), compiled and inked to the forty-ninth parallel.

Sheet M 15, Minnesota portion, compiled and inked; Canadian portion to the forty-ninth parallel, compiled and inked.

Sheet L 15, Wisconsin portion, compiled and inked; Minnesota portion, compiled and inked as far west as the ninety-fifth meridian.

Sheet K 15, Wisconsin portion, compiled and inked.

Sheet K 17, New York, Pennsylvania, and West Virginia portions, compiled and inked; Ohio portion, compiled and 60 per cent inked; Michigan portion, compiled, inked, and lettered..

Sheet J 17, Ohio portion, compiled and 30 per cent inked; Pennsylvania portion, compiled and inked.

Sheet K 16, Michigan portion, compiled, inked, and lettered; Indiana portion, compiled and inked; Ohio portion, compiled; Wisconsin portion, transferred from a reduction of the area on the special scale, inked, and lettered.

Sheet J 16, Indiana portion, compiled and inked; Ohio portion, compiled and 50 per cent inked.

Sheet II 14, a special area extending about 1½° north and 2° west of Austin, Tex., compiled, inked, and lettered.

WATER-RESOURCES BRANCH.

INVESTIGATION OF POWER SITES.

The character and usefulness of the work performed by the water-resources branch have been discussed in previous reports. The most prominent feature of the last year's work is the investigation of power sites on the public lands. Nearly 1,500,000 acres have been designated for temporary withdrawal from entry. This work was performed so that the power sites now remaining in federal ownership might be retained pending suitable consideration of the matter by Congress. The withdrawal act, approved June 25, 1910, provides that—

> The President may, at any time in his discretion, temporarily withdraw from settlement, location, sale, or entry any of the public lands of the United States, including the District of Alaska, and reserve the same for water-power sites, irrigation, classification of lands, or other public purposes to be specified in the orders of withdrawals, and such withdrawals or reservations shall remain in force until revoked by him or by an act of Congress.

The lands withdrawn for power sites are located in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. A statement of the acreage represented in each State is given on page 48. Although the withdrawals were made through the agency of the Survey's land-classification board, nearly all the designations of land suitable for the purpose were made by the water-resources branch. These designations were based largely on information collected by the Survey during the last thirty years. Some of it was specific, actual power sites being located and defined. The greater proportion of the withdrawals were, however, based on general information collected incidentally during the progress of previous investigations. Such information usually consisted of a knowledge of the slope and flow of a river, derived from specific surveys made by the topographic branch, or from river profiles and gagings previously made by the water-resources branch. Data for Columbia River were furnished by the Corps of Engineers, War Department. Specific information was also obtained from published and unpublished notes and maps made in the course of geologic investigations. One of the most interesting incidental features of the water-power work was the demonstration of the utility of the investigations made by the Survey for other purposes during past years, affording evidence of the wide scope and comprehensiveness of the Survey's previous work.

Since the adoption of the power-site withdrawal policy it has been the practice of the Commissioner of the General Land Office to refer all right-of-way applications to the Geological Survey for an opinion as to whether the granting of them would "interfere with the use of any valuable power site desired to be withdrawn by the Geological Survey pending contemplated legislation." These applications have brought to the Survey's attention many sites that would otherwise have been unrecognized until a later date, when the property would have been examined in the regular course of work.

Field examination is required to confirm or to disprove the assumptions made with reference to the power-site lands withdrawn on general information, as above described. There are certain tracts that on critical investigation will prove not to be adapted for power purposes. Indeed, such examinations as have already been made have resulted in the restoration to entry of many tracts. Some rivers are known to have a certain slope in a given distance, indicating that power development may be possible along that reach, and all the public land bordering that reach is withdrawn from entry. Subsequent field examination, however, may show that the greater part of that slope occurs within only a short distance along the river and that the remainder, or the greater part of it, is valueless for the development of power. Again, it may be found that although a certain withdrawn reach of river has a decided fall and therefore is apparently well adapted for power development, the water supply is not sufficient to afford a good power. These and other conditions may affect the value of lands withdrawn for power sites on general information, and therefore emphasize the necessity for field examinations and surveys. It is the purpose to push this work so far as may be possible with the appropriations available during the coming year and to restore to entry all lands not found useful for power-site development.

The previous work of the Survey in the measurement of stream flow in the West has been and will be of the highest importance in determining many of the necessary facts. Much remains to be done in the gaging of stream flow in rivers on which power sites have been withdrawn. The logical work for the immediate future relative to these sites must therefore be, first, the critical examination of these lands with reference to their specific suitability for power development, and second, the observation of stream flow to determine how much power may be made available. There is no present basis on which to estimate the amount of power that may be developed at many of these sites. Gaging stations will be established on all unmeasured rivers along which lands have been withdrawn.

It has been found necessary to determine what shall be considered a power site, suitable for withdrawal, and how much land shall be withdrawn to protect it. To do this the necessities in the case must first be defined and then interpreted according to what may be considered a reasonable federal policy. The subject is broad and provocative of many diverse opinions. It is therefore necessary to adopt standards which seem to cover in the widest degree the important points involved.

A reform is usually the result of abuses, present and past. The water-power land reform is no exception to the rule. Among the most widely discussed abuses in this country at present are those which many persons apprehend as a result of the centralization of water powers in common ownership covering wide fields and dominating a great market. It would be strange indeed if this great industry should not, in common with all others of importance, gravitate toward the modern industrial idea of centralization. All the industrial economies resulting from centralization apply to this as to other industries. It can hardly be expected that the familiar abuses will not creep in unless they are restrained. There is, however, a physical difference which sets the water-power industry apart from many of the others. To be of the highest utility water power must meet the market's demands. It must instantaneously adapt itself to market fluctuations. These fluctuations occur, not from season to season, but from hour to hour. A water power that may be sufficient to meet all demands at noon may be quite insufficient to meet the demands of a few hours later. At another place the period of maximum load may be the reverse, or at a quite different time. The capacity of a single water power can not, except under unusual conditions, be fully adapted to a general market, but the capacity of many united water powers can easily be so distributed as to cover varying necessities. In this way the shortage at one place at a certain time can be compensated by the surplus at another place at that time. The situation is analogous to that of the car-dispatching system of a railroad. It would not be good management to have each division of a railroad equipped with rolling stock sufficient to respond to the maximum demand of that division. Cars are shifted from one division to another according to local demand. So it is with a power system. If each unit of a power system must respond to the maximum demands in the locality of that unit, then it is plain that there will be a large waste of resources represented by idle machinery during the hours of minimum use in each locality. Needless to say, the cost of power to the ultimate consumer would have to be increased in like proportion.

There is then a physical necessity for consolidation in water power. To prevent abuses, it is not necessary to prevent consolidation. Abuses may be constructively restrained. How shall this be done in the case of powers on the public lands?

The only feasible way at present is to withdraw the power sites from general entry, to put them in a special class, under either national or state control, and to stipulate that when they are developed they shall be operated subject to reasonable regulations. Such a plan provides for those sites which are to be developed in the near future, as well as those for which there may be no demand in a century. The developments in the future will be quite as important as those of the present, yet while the sites are awaiting development they should be relieved from all property entanglements and be subject to regulation when the market demands them. None should be taken up for speculation under another guise. None should pass from government ownership except for immediate and purposeful use. It is plain that the only way by which the Federal Government can, under present statutes, properly conserve the water powers of the public domain is by withdrawing them from entry pending the enactment of appropriate legislation.

Many lands on which power may be developed are nevertheless more useful for irrigation. The present policy of the department is based on the "higher use." Any tract of land that has a higher use for irrigation or any other industrial purpose than for power should be devoted to that use. It is equally true that in many places, though irrigation may be the higher use, the power use can also be preserved.

CAREY ACT SEGREGATIONS.

The water-resources branch has been obliged to consider during the year a large number of proposed Carey Act segregations for the purpose of determining whether the contemplated water supply is sufficient to properly irrigate the acreage applied for. This is a most important matter. Although the Government does not by virtue of the Carey Act guarantee the success of any project, the fact that it is supposed to look well into the conditions controlling any of these projects and to grant the lands necessary only after it has satisfied itself under the law and under the rules of the department that the proposition is a worthy one places an implied obligation on the department to reduce the area allowed for segregation to that which can safely be served by the available water supply. The general impression has been spread widely by those interested in the promotion of such projects that they must be safe because the Government has so guaranteed, and as a result many settlers have invested in these projects with that erroneous idea. Many applications for Carey Act grants have been referred to the Geological Survey, and examinations have been made by the aid of stream-flow records that have been collected during previous years. As a result certain projects have been shown to be deficient in water supply. Thus protection is accorded to the prospective settler on these tracts.

AUTHORITY FOR INVESTIGATIONS.

The water-resources investigations of the year were made under the authority of the following clause in the sundry civil act:

> For gauging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and the preparation of reports upon the best methods of utilizing the water resources, one hundred thousand dollars.

This amount, which has been appropriated annually for several years, is not sufficient to perform the required work in all parts of the United States. It is therefore necessary to select each year the areas in which the work is to be done. This selection is based, first, on the relative importance of the investigations in the various parts of the country with especial reference to the needs for information concerning the amount and character of both surface and underground waters; second, on the amount of work previously performed in the several parts of the country, those areas that have had the least attention in the past receiving preference.

ALLOTMENTS.

The allotments from the appropriation for the last fiscal year are as follows:

Allotments from appropriation for stream gaging, etc.

Administrative salaries of the Survey	$5,271
Clerical assistance and supervision of work	9,980
Purchase of supplies and equipment	500
Computations, reports, and technical studies	10,080
Stream gagings in—	
New England and New York	5,750
New Jersey, Pennsylvania, and Maryland	500
Virginia, South Carolina, North Carolina, Georgia, Alabama, Mississippi, and Tennessee	6,000
West Virginia, Kentucky, Ohio, Indiana, and Illinois	5,500
Southern Wyoming, Colorado, and New Mexico	7,500
Northern Wyoming, Montana, and North Dakota	4,500
Idaho, Utah, and Nevada	5,500
Washington and Oregon	7,500
California	4,500
Field inspection	4,000
Ground-water investigations	13,810
Investigations of quality of water	7,550
Débris investigations	2,000
Contingent	59
	100,000

COOPERATION.

STATES.

Cooperation with several States has been maintained, as described in previous reports, the States and the amounts allotted by them being given in the following table:

Amounts allotted by States for cooperative hydrographic work.

California	$9,000	New York	$5,000
Idaho	2,000	Oregon	2,500
Illinois	2,000	Utah	2,000
Maine	3,300	Vermont	1,000
Massachusetts	1,050	Washington	5,000
Minnesota	17,500		
New Mexico	2,500		52,850

The work performed under these agreements is outlined in the following paragraphs:

California: The determination of the flow of rivers, together with the survey of reservoir, dam, and canal sites for the purposes of development of irrigation, water power, and municipal supply; also the study of underground waters.

Idaho: The determination of the amount of water flowing in rivers.

Illinois: The determination of stream flow, especially low waters and flood heights, for use as a basis for the drainage of swamp and overflow lands.

Maine: The determination of stream flow and the survey of river profiles and reservoir sites.

Minnesota: The determination of stream flow and the survey of river profiles and reservoir sites.

New Mexico: The determination of stream flow for irrigation and water-power purposes.

New York: There are two cooperative agreements in force in this State—one with the state engineer, in which $1,500 is expended by each party for the determination of stream flow at points designated by the state engineer, and the second with the state water supply commission, amounting to $3,500 by each party, the money being devoted to the examination of stream flow for storage and water-power purposes.

Oregon: The determination of stream flow for irrigation and water-power purposes.

Utah: The determination of stream flow for irrigation purposes.

Vermont: The determination of stream flow and the survey of river profiles.

Washington: The determination of stream flow for irrigation and water-power purposes and the survey of river profiles and reservoir sites.

RECLAMATION SERVICE.

Cooperation has also been maintained with the United States Reclamation Service. The rivers supplying water to the reclamation projects under construction by that bureau must necessarily be investigated to determine the amounts of water that they will yield for irrigation. This work, being specifically applied to these projects, becomes a proper charge thereon, and the Reclamation Service has deemed it of advantage to utilize the Survey engineers for this work, paying to the Survey, through transfer of funds in the Treasury Department, the actual cost of the investigations. During the last year 152 stations have been maintained under this cooperative agreement.

OFFICE OF INDIAN AFFAIRS.

Cooperation has also been effected with the Office of Indian Affairs in connection with ground-water investigations. At the request of the Commissioner of Indian Affairs a study of ground-water supplies was undertaken in the Moki and Navajo reservations of Arizona, New Mexico, and southern Utah, $3,000 being set aside for this purpose by the Indian Office. A report, with recommendations, based on this study and intended for the guidance of representatives of the Indian Office who are responsible for water development in this region, has been transmitted to the Commissioner.

Stream-flow investigations on Indian reservations have also been placed in charge of the Geological Survey by the Commissioner of Indian Affairs. The work during the last year has been performed on the following reservations:

Indian reservations on which investigations of stream flow have been made.

	Number of stations.
Montana:	
Blackfeet	7
Fort Belknap	1
Fort Peck	4
Crow	1
Wyoming: Shoshone	15
Idaho: Fort Hall	3
Washington: Yakima	12
Oregon:	
Warm Springs	1
Klamath	2

The cost of this work has been paid by transfer in the United States Treasury from the Indian Office appropriation.

FOREST SERVICE.

At the request of the Forester a geologist was detailed to the Paulina district, in eastern Oregon, to advise the local forest officials as to the possibility of developing underground waters in that area for domestic and stock purposes and, further, to assist in determining the depths of wells for which contracts are to be let in the future. The amount set aside by the Forest Service and expended in this work was approximately $400.

PUBLICATIONS.

The work of the water-resources branch is represented in the following publications issued during the year: Professional Paper 65;

Water-Supply Papers 232 to 236, 238, 239, 241 to 245, 247 to 250, and 252. Titles and brief summaries of these publications are given on pages 15, 21–23. Seven other papers were in press at the close of the year, 3 have been submitted for publication, and 34 are in different stages of preparation.

CHARACTER OF INVESTIGATIONS.

The investigation of water resources in the United States involves work of three kinds. One is the determination of river flow, which is the basis for the development of storage, water power, irrigation, flood prevention, and land drainage. Another is the determination of the occurrence, location, and amount of underground waters. The third is the study of the quality of water, both surface water and that occurring underground, and its fitness for the various industrial and domestic uses. The problems involved are of engineering, geologic, and chemical character and wide fields are covered in each of these branches of science.

MEASUREMENTS OF RIVER FLOW.

DISTRICTS AND GAGING STATIONS.

The methods followed in gaging streams are discussed in detail in the printed annual progress reports of the work. (See Water-Supply Papers 241–252.) For administrative purposes the country is divided into districts, each in charge of a district engineer, as follows:

New England district: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. T. W. Norcross, district engineer, 6 Beacon street, Boston, Mass. District engineer in subdistrict of Maine, C. C. Babb, state capitol, Augusta, Me.

New York district: New York, New Jersey, and northern Pennsylvania. C. C. Covert, district engineer, Federal Building, Albany, N. Y.

Middle Atlantic district: Southern Pennsylvania, Maryland, Delaware, Virginia, and the eastern part of West Virginia. R. H. Bolster, district engineer, Washington, D. C.

Southeastern district: North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Tennessee. M. R. Hall, district engineer, Federal Building, Atlanta, Ga.

Ohio Valley district: Ohio, Indiana, Illinois, Michigan, middle Missouri, and Arkansas. A. H. Horton, district engineer, Federal Building, Newport, Ky.

Upper Mississippi district: Minnesota, Wisconsin, and Iowa. Robert Follansbee, district engineer, Old Capitol Building, St. Paul, Minn.

Denver district: Southern Wyoming, Colorado, and New Mexico. W. B. Freeman, district engineer, Commonwealth Building, Denver, Colo.

Upper Missouri district: Northern Wyoming, Montana, North Dakota, and South Dakota. W. A. Lamb, district engineer, Helena, Mont.

Great Basin district: Utah, Idaho, and Nevada. E. C. La Rue, district engineer, Brooks Arcade, Salt Lake City, Utah.

Columbia River district: Oregon and Washington. J. C. Stevens, district engineer, Tilford Building, Portland, Oreg.

California district: California and Arizona. W. B. Clapp, district engineer, Federal Building, Sacramento, Cal.

The results of the work performed in these districts are compiled and computed for publication by the computing section in the Washington office, under the charge of R. H. Bolster, assistant engineer. The distribution of the gaging stations by States is as follows:

Stream-gaging stations, by States.

State.	Number of river stations.	Number of measurements.	New stations established in year ending June 30.	Stations discontinued during year ending June 30.	Number of stations maintained in cooperation with state or federal bureaus.
Alabama	9	16	0	0	8
Arizona	0	0	0	0	0
Arkansas	6	0	6	6	6
California	72	674	1	2	42
Colorado	43	951	6	12	19
Connecticut	2	0	0	0	2
Delaware	0	0	0	0	0
District of Columbia	1	0	0	0	0
Florida	0	0	0	0	0
Georgia	17	84	2	1	9
Idaho	44	344	19	6	44
Illinois	23	165	6	0	23
Indiana	1	2	0	0	1
Iowa	1	0	0	0	0
Kansas	0	1	0	0	0
Kentucky	0	0	0	0	0
Louisiana	0	1	0	0	0
Maine	30	99	10	4	30
Maryland	2	6	0	0	0
Massachusetts	16	82	9	0	16
Michigan	8	0	0	0	1
Minnesota	51	251	22	9	51
Mississippi	9	9	0	0	8
Missouri	1	2	1	0	1
Montana	94	443	6	3	72
Nebraska	6	28	0	0	6
Nevada	11	33	1	4	6
New Jersey	3	3	0	0	2
New Hampshire	8	24	2	0	0
New Mexico	32	194	11	3	23
New York	39	176	3	5	39
North Carolina	15	38	0	7	1
North Dakota	19	12	0	7	12
Ohio	4	8	1	0	3
Oklahoma	0	0	0	0	0
Oregon	94	128	10	7	71
Pennsylvania	0	0	0	0	0
Rhode Island	5	40	5	1	5
South Carolina	4	12	0	0	1
South Dakota	0	5	0	0	0
Tennessee	7	13	0	0	5
Texas	8	1	0	0	8
Utah	49	293	10	0	48
Vermont	9	48	1	0	9
Virginia	16	35	0	3	1
Washington	71	515	14	8	58
West Virginia	21	48	0	0	2
Wisconsin	6	0	0	0	1
Wyoming	21	40	0	17	21
	878	4,824	146	105	655

NEW FEATURES OF THE WORK.

Special attention has been given during the year to raising the standard of the progress report on stream measurements. The methods of computation have been revised so as to insure much greater accuracy in the results than heretofore. This work has been under the direct supervision of R. H. Bolster, who has had many years' experience in work of this class. He has been assisted by a corps of trained men, who, under his direction, make up a computing section that is to be a permanent feature of the water-resources branch.

In order to insure the greatest accuracy in the data, they are carefully reviewed by the field men before being transmitted to this office. These data, with full notes on all special points, form the basis for the work in the computing section, where the final estimates are made. These estimates are then submitted to the district engineers for inspection, so that all published results have a double check.

All the descriptive matter in the progress reports has been carefully revised and all nonessential material eliminated.

The physical conditions governing the work of stream gaging are such that the data for the different stations can not be of the same standard of accuracy. In order that the engineer using the report may know what reliance to place on the results given, a column has been added to the monthly estimate table for each station, showing the probable error.

The increased demand for water for municipal supply, irrigation, and other uses has forced the utilization of many small sources of supply which heretofore have not been considered important. This has created a demand for data on the small streams, and every effort has been made to meet this demand.

During the year the instruments for determining stream flow have been greatly improved, with the result both of facilitating the work and of increasing the accuracy of the results. A new automatic gage, which gives a printed record of the time and stage of the river for every fifteen minutes, has been developed by Gurley & Co., of Troy, N. Y., from preliminary plans and suggestions given by the engineers of the water-resources branch. It is believed that this instrument will be a large factor in future stream-gaging work, as the diurnal fluctuations in most streams, due to natural and artificial conditions, require a continuous record of stage in order to obtain accurate results.

To facilitate the use of government reports relating to water supply, climate, etc., the United States has, by agreement between the Survey and the Weather Bureau, been divided into twelve areas and the progress report of stream gaging has been divided into twelve parts, each part covering one of these areas. The areas and the numbers of the corresponding reports giving the results for 1907–8 and for 1909 are as follows:

Areas represented by progress reports.

Area.	Water-Supply Paper No.	
	1907–8.	1909.[a]
North Atlantic coast	241	261
South Atlantic coast and eastern Gulf of Mexico	242	262
Ohio River basin	243	263
St. Lawrence River basin	244	264
Upper Mississippi River and Hudson Bay basins	245	265
Missouri River basin	246	266
Lower Mississippi River basin	247	267
Western Gulf of Mexico	248	268
Colorado River basin	249	269
Great Basin	250	270
California	251	271
North Pacific coast	252	272

[a] The reports for 1909 have not yet been published.

RIVER-PROFILE SURVEYS.

Preliminary river-profile surveys in advance of topographic mapping have been made during the year in Maine, Minnesota, and Oregon. The work in Minnesota was done at the expense of the State, but under the direction of the Geological Survey. Certain reservoir-site surveys formed a part of these examinations. The localities of the work are given in the following table:

River-profile surveys, fiscal year 1910.

Minnesota:	Linear miles surveyed.
Root River	108.3
Rum River	140.6
Red Lake River	142.8
Cannon River	65.3
Cloquet River	62.0
St. Louis River	162.0
Ottertail River	58.6
Crow Wing River	89.7
Lake Millelacs.	

Maine:
- Umbagog Lake.
- Lower Richardson Lake.
- Upper Richardson Lake.
- Mooselucmaguntic Lake.
- Mooselucmaguntic Lake Outlet.
- Richardson Lake Outlet.
- Abraham Pond.
- Scammons Pond.

Maine—Continued.
- Molasses Pond.
- Webbs Pond Outlet.
- Alligator Pond.
- Rocky Pond.
- Spectacle Pond.
- Great Pond.
- Green Lake Outlet.
- Branch Lake Outlet.
- Union River, Goodwins Bridge to Great Pond.
- Union River, Ellsworth to Great Pond.

Washington:
- Klickitat River.
- Lewis River.
- Toutle River.
- White Salmon River.
- Little White Salmon River.

GROUND-WATER INVESTIGATIONS.

At the beginning of the fiscal year $13,810 was set aside as a special allotment for the investigation of underground waters. Of this amount, $4,000 was transferred to the division of geology for expenditure under the supervision of the chief geologist in the investigation of the ground waters of the Atlantic and Gulf coastal plains, and an additional amount of $1,080 was allotted for clerical assistance, leaving $8,730 for the study of ground waters. This sum was devoted to investigations in California, New Mexico, Utah, Arizona, and north-central Texas.

A two years' field investigation of the springs of California, begun in the fiscal year 1909, was continued during 1910, and at its close the work was advanced to such a point that an additional month's field work, to be followed by a month's office work, will result in the completion of a full report. This work has been done by G. A. Waring. Near the close of the fiscal year 1910 Mr. Waring was invited by the Republic of Brazil to initiate studies of water resources in that country of the same general character as those carried out by the United States Geological Survey. Mr. Waring has accepted this invitation and will depart for his new field in September, 1910.

The work in the State of Iowa, begun several years ago, has been brought to a close during the present year, and a voluminous report embodying the results has been prepared under the general supervision of W. H. Norton, of Mount Vernon, Iowa, the part dealing with the chemistry of the waters being prepared by W. S. Hendrixson, of Iowa College. In order to complete the work within the year, O. E. Meinzer, of the Survey staff, was assigned to Professor Norton to complete certain county descriptions. This field work was finished in the autumn of 1909, and Mr. Meinzer's report was prepared and embodied with the rest of the Iowa material. This entire report, which is considered to be of much importance, is now in course of preparation for publication and should be issued during the next fiscal year.

In addition to the Iowa work Mr. Meinzer was assigned to a study of ground-water conditions in the Estancia Valley, New Mexico, and also undertook some studies in Utah to supplement those commenced by him during the fiscal year 1909. The Estancia Valley report has been written and transmitted for publication, and at the close of the fiscal year the Utah report is nearly completed.

A small allotment has been set aside for the use of C. H. Gordon, of the University of Tennessee, Knoxville, Tenn., to enable him to complete a report on the geology and underground waters of north-central Texas, his report on the northeastern part of this State having been submitted during 1909. The later report is about complete at the close of the fiscal year and will probably be submitted for publication during the summer.

Studies of ground-water conditions in the Moki and Navajo reservations, undertaken by H. E. Gregory at the request of the Office of Indian Affairs during the previous year, were continued in the fiscal year 1910, and a report embodying Professor Gregory's conclusions was forwarded to the Indian Office for its guidance in the development of underground water on the reservations. The Indian Office has set aside an additional sum of $1,500 for the extension of these investigations during the fiscal year 1911 and Professor Gregory has been assigned to this field to continue the work and to prepare the desired report.

At the request of the Forest Service a brief examination of conditions of the water supply in the Paulina district in eastern Oregon was undertaken by the Geological Survey during May and June, 1910. This study, likewise made by Professor Gregory, was completed and its results were transmitted directly to the Forest Service officials in the Portland district.

W. C. Mendenhall, in administrative charge of ground-water investigations, remained in the Washington office until late in the summer reviewing reports and preparing them for publication. In the fall he made a reconnaissance through three districts in eastern and central Washington and in Owens Valley, California. Later, accompanied by H. R. Johnson, who resigned from the service early in the fiscal year to enter private work, he reviewed Mr. Johnson's field work in the Antelope Valley and the southern parts of the Mohave Desert in California. Subsequently Mr. Johnson's report was completed and at the close of the fiscal year submitted for publication. Mr. Mendenhall also made some studies in the San Jacinto Valley in California during the early winter, but these were interrupted before their completion and a report on this field has not been prepared. A large part of Mr. Mendenhall's time toward the close of the year was expended in the review of manuscripts and in general routine and committee work for the Survey.

The greatest demand for ground-water studies comes from the arid States, where surface supplies are not available or are meager. The stimulus given by the enlarged-homestead act to the settlement of arid and semiarid districts has increased this demand, for in many places settlement is possible or dry farming is successful only if sufficient ground-water supplies can be procured for domestic and stock purposes. It is planned to investigate the arid and semiarid valleys of the West in advance of settlement, so far as the limited funds, the cooperative agreements, and other considerations permit.

INVESTIGATIONS OF THE QUALITY OF WATER.

In 1905 a study was commenced with the object of ascertaining the mineral content of surface waters of the United States in relation to geologic, climatic, and other conditions and especially in relation to chemical denudation. With this end in view and with the cooperation of the Reclamation Service, of state authorities in California, Illinois, Kansas, and Washington, and of many municipalities daily samples of water have been collected from the principal streams of the country at about 240 stations and the composite samples from these have been analyzed, a collection having been thus obtained of about 6,000 mineral analyses comparable with each other and indicative of the amount and character of the mineral matter carried by the streams of the United States.

During the fiscal year 1910 much of this work has been brought to a close and several reports on it have been completed. Water-supply papers on the quality of surface waters of California (No. 237), by Walton Van Winkle and F. M. Eaton; of Illinois (No. 239), by W. D. Collins; and of the United States east of the one hundredth meridian (No. 236), by R. B. Dole, have been published. A report has been prepared on the quality of the waters of Kansas, by H. N. Parker. The study of the quality of streams of the arid States conducted by the Reclamation Service has been correlated with similar work by the Geological Survey, and the manuscript containing the analyses of the waters has been prepared by Herman Stabler for publication as a water-supply paper. Part 2 of the "Quality of surface waters of the United States east of the one hundredth meridian" has been commenced by R. B. Dole and is to be completed during the next fiscal year.

In November, 1910, under a cooperative agreement with the state board of health of Washington, a study of the surface waters of that State, particularly in the Columbia River basin, was begun. Twenty stations for the daily collection of samples have been established and the chemical analyses are being made by Walton Van Winkle in a laboratory placed at the disposal of the Survey by the University of Washington. It is planned to complete the field studies and to prepare the report on them during the fiscal year 1911.

The completion of the Washington work will conclude this study of the quality of surface waters, by which the Survey will have obtained data covering the average quality and the general fluctuations in mineral content of most of the larger bodies of surface water in the United States.

In March, 1910, H. N. Parker resigned to enter private work. During the first six months of the fiscal year 1910 R. B. Dole was furloughed, being on duty for the Department of State in Ecuador. Since his return the greater part of his time has been consumed in supervision of the work on the quality of water, in review of manuscripts, and in the preparation of several papers on the chemical composition of underground waters, to accompany special reports. For the first four months of the year Walton Van Winkle was in charge of the chemical laboratory at the Alaska-Yukon-Pacific Exposition and later organized the study of waters in the State of Washington.

During the fiscal year 1910 the sum of $5,500 has been expended in investigations dealing with the quality of water. At the close of this year these investigations have been combined with those of underground waters, for under present conditions the studies of quality are confined almost exclusively to ground waters.

DÉBRIS INVESTIGATION.

The investigation of the natural laws governing the transportation of suspended material by rivers, described in previous reports, was discontinued on January 1, 1909. The results, covering a period of three and one-half years' experimentation, are now being compiled. They show certain fundamental relations between the amount of material carried by streams under varying conditions of slope, depth, width, etc. Although the work was carried on under laboratory conditions—that is, in small troughs and with artificially applied water and débris—certain relations, exponential and others, are indicated which, with suitable modifications, may be applied to practical conditions. The treatment of rivers in which suspended matter is a large factor has been based on rules that are largely empirical. It is believed that the application of the laws discovered in these investigations will have a wide and valuable application.

PERSONNEL.

The work during the year has been in charge of M. O. Leighton, chief hydrographer, and J. C. Hoyt, assistant chief hydrographer.

TECHNOLOGIC BRANCH.

ORGANIZATION AND SCOPE.

The organization of the technologic branch includes three divisions corresponding to the three separate appropriations—mine accidents, fuels, and structural materials. The work under these divisions was continued throughout the fiscal year as in the year previous.

The general supervision of the work has also remained as during the previous year, under Joseph A. Holmes, expert in charge, afterward chief technologist; Herbert M. Wilson, chief engineer, afterward assistant chief technologist; J. C. Roberts, assistant chief engineer, in charge of the Pittsburg experiment station, assisted by A. W. Belden.

In the mine-accidents division the technical force consisted of 5 mining engineers, 2 assistant engineers, 4 junior engineers, 1 explosives engineer, 1 junior testing engineer, 1 geologist, 1 assistant geologist, 1 electrical engineer, 1 junior electrical engineer, 1 consulting electrical engineer, 1 chemist, 1 explosives chemist, 2 assistant chemists, 1 junior chemist, and consulting mining engineers employed temporarily as needed.

In the fuel division the technical force consisted of 3 engineers in charge, 1 metallurgical engineer, 2 engineers, 13 assistant engineers, 15 junior engineers, 2 consulting engineers, 1 chief chemist, 5 chemists, 8 assistant chemists, 17 junior chemists, 1 physicist, 1 peat expert, 1 laboratory assistant, and 3 laboratory helpers.

In the structural-materials division the technical force consisted of 1 engineer in charge, 1 metallographer, 1 engineer, 3 assistant engineers, 8 junior engineers, 1 engineer of tests, 1 chemist, 1 assistant chemist, 10 junior chemists, 1 ceramic chemist, 1 assistant ceramic chemist, 2 junior ceramic chemists, 1 assistant geologist a portion of the time, in addition to 1 laboratory helper and 2 apprentices.

LABORATORIES AND TESTING FACILITIES.

No material enlargement of the facilities for testing and research was made during the fiscal year other than that incident to steady development in the mine-accidents and structural-materials divisions. As the appropriation for fuel testing was $100,000, as against $250,000 the year before, a corresponding curtailment in the extent and variety of the operations and in the personnel of the fuel division for the year was necessary.

The facilities for structural-materials investigations at the Pittsburg experiment station were increased by the construction and equipment of a kiln house, containing several types of kilns for the burning of brick, tile, and other clay products.

A laboratory was established at Atlantic City, N. J., for the investigation of the influence of sea water on concrete and of sea water and salt air on paint used as a preservative of structural materials; this was continued in operation throughout the year, as was also the laboratory at Northampton, Pa., for testing cement for use in the construction of the Panama Canal.

The small explosives testing gallery No. 2 at Pittsburg was equipped with necessary appliances for use in testing electric motors, electrically operated mining machines, and other electric equipment in the presence of explosive mixtures of gas.

During the year four substations were established as headquarters for investigations of the mining engineers—one in the Federal Building, Knoxville, Tenn.; one in a building of the University of Illinois, provided through the cooperation of the Illinois State Geological

Survey at Urbana; one in the Philippine Exposition Building on the grounds of the State University, Seattle, Wash., in cooperation with the state mine inspector of Washington; and one at McAlester, Okla., in cooperation with the state mine inspector for the Five Civilized Tribes and the Oklahoma Coal Operators Association. Each of these buildings was equipped with gas-tight rooms and the necessary apparatus for training miners in rescue work.

PUBLICATIONS.

During the fiscal year 12 bulletins (Nos. 382, 383, 387, 388, 392, 393, 402, 403, 412, 416, 418, and 423) were issued. Titles and brief summaries of these bulletins are given on pages 17–21. Seven of them relate to fuel testing, 3 to structural materials, and 2 to mine accidents. One is in press, 18 have been submitted for publication, and a number of others are in different stages of preparation.

MINE-ACCIDENTS DIVISION.

The organization and researches of the mine-accidents division were continued during the fiscal year as reported for the last year.

The inspection of coal mines in the Territory of New Mexico was continued under Jo E. Sheridan, mine inspector, and the work was kept current.

G. S. Rice, assisted by R. Y. Williams, J. J. Rutledge, H. M. Wolflin, and L. M. Jones, and for a portion of the year by A. C. Ramsay, David White, J. W. Groves, and C. A. Fisher, examined and sampled a number of coal mines in West Virginia, Illinois, Missouri, Pennsylvania, Ohio, Utah, Washington, and other States. These samples were collected and analyzed for one or another branch of the government service, in connection with the purchase of coal for the use of the Government, and this work has been done in cooperation with the fuel division. In Washington, Illinois, and Missouri the state geologists cooperated in the collection of the coal samples. In all, 355 mines were inspected and 1,476 coal samples, 158 samples of mine dust, and 134 samples of mine air were taken for analysis.

These engineers have also visited the scenes of explosions and mine fires and investigated the condition of the mines, sampled and tested the coal dust and gas, and made other studies with a view to determining the cause of the disasters. They have also carried on experiments to determine the influence of sprayed water or steam and of calcium chloride, etc., as means of preventing dust explosions.

J. W. Paul, assisted at various times by F. F. Morris, F. W. Horton, L. M. Jones, A. C. Ramsay, assistant mining engineers, and J. R. Cavanaugh, coal miner, has continued investigations and tests of safety lamps and of the efficiency of various types of rescue apparatus. With the cooperation of the mining engineers, Mr. Paul has supervised the training of practical miners in the use of rescue apparatus, in order to secure their assistance in investigations in the different coal fields. In connection with investigations of the mines, the mining engineers and assistants and the chief technologist aided state officials at 21 mine disasters, at the following places:

Mine explosions:
  Roslyn, Wash., October 3, 1909.
  Hartshorne, Okla., October 21, 1909.
  Johnstown, Pa., November 1, 1909.
  Herrin, Ill., December 23, 1909.
  Primero, Colo., January 31, 1910.
  Drakesboro, Ky., Lowder or Wickliffe mine, February 1, 1910.
  Ernest, Pa., February 5, 1910.
  Stearns, Ky., February 8, 1910.
  Craig, Okla., March 8, 1910.
  Bolen-Darnal, Okla., March 8, 1910.
  Wilberton, Okla., March 31, 1910.
  Ensley, Ala., April 21, 1910.
  Amsterdam, Ohio, April 22, 1910.
  Palos, Ala., May 5, 1910.
Mine fires:
  Duquoin, Ill., September 20, 1909.
  Cherry, Ill., November 13, 1909.
  Copper Hill, Tenn., November 29, 1909.
  Artemus, Ky., December 28, 1909.
  Cumberland, Ky., January 2, 1910.
  Artemus, Ky., Sturgis mine, January 6, 1910.
  South Bartonville, Ill., February 2, 1910.

Tests of the several types of rescue apparatus were made to determine their efficiency and safety under conditions of service use and for maximum periods of time. Tests have also been made and are still in progress on the various types of safety lamps and electric safety lamps in general use.

Clarence Hall, explosives engineer, with S. P. Howell, assistant engineer, and A. B. Coates and A. J. Hazlewood, junior engineers, made physical tests of explosives, with a view to determining their permissibility in coal-mining operations. In all 28 explosives passed the tests provided during the year and were announced in two different circulars issued in October, 1909, and May, 1910. The tests made included the following: Trauzl lead blocks, 114; small lead blocks, 86; rate of detonation of burning, 253; flame tests, 158; gallery No. 1, 1,272; ballistic pendulum, 401; pressure gages 1 and 2, 204; miscellaneous, 198.

On each Saturday throughout the year demonstrations were given at the Pittsburg testing station to organizations of state mine inspectors, mining associations, groups of coal operators, and their superintendents, foremen, and mine workers. These have included tests to show the safety or danger of the explosives used when detonated in the presence of explosive mixtures of mine gas, coal dust, and air in proportions similar to those occurring in the mines. Public demonstrations of the safety of mine lamps and of the use and method of operating mine rescue apparatus were also conducted throughout the year.

Chemical analyses of each of the explosives and of the gas resulting from the firing of the explosives and from the explosion of the materials used in conducting the investigations were continued throughout the year under W. O. Snelling, chemist, assisted by C. G. Storm, A. L. Hyde, W. C. Cope, assistant chemists, and C. A. Lambert, junior chemist. In this work 2,500 chemical analyses of explosives used in mining and 750 physical tests were made.

H. H. Clark, electric engineer, assisted by William Buhl, jr., continued investigations and tests relative to the use of electricity in mining and its relation to mine explosions. This work included a series of competitive tests of blown-out fuses in the presence of dangerous mixtures of mine gas and air, the investigation of insulation for electric wiring, and tests of incandescent lamps in similar mixtures and of coal-cutting machines.

FUEL DIVISION.

The organization of the fuel division continued throughout the year practically as during the preceding year, except that as a result of the reduction in appropriation a considerable curtailment was necessary in the large-scale producer-gas, briquetting, and steaming tests, and there was a corresponding reduction in the personnel engaged on these tests. The energies of the division were taxed to keep up the routine analyses and tests of coal purchased by the Government, including the special tests required by the Quartermaster's Department to ascertain the fuel equivalent of one cord of oak wood.

A number of tests of the briquetting properties of lignite without binder were made on the large German briquetting press, and a series of investigative tests were made in the long combustion chamber, with a view to solving certain problems relative to processes of combustion. A certain amount of necessary investigative chemical work on fuels was continued throughout the year.

The inspection of fuels used by the Government was continued under G. S. Pope, assisted by P. M. Riefkin, J. W. Peters, N. H. Snyder, A. A. Straub, W. J. Harris, jr., E. W. Miller, and H. H. McKee. This work included the preparation of specifications for use in the purchase of coal by purchasing officers in the city of Washington and elsewhere in the United States, also by the general supply committee and the Panama Railroad Company and Isthmian Canal Commission. Inspectors were permanently stationed at New York City and Norfolk, Va., and trips were made by Messrs. Pope and Riefkin to Boston, Omaha, St. Louis, Kansas City, Chicago, and other cities in order to give advice and assistance in connection with local coal problems. Mr. Riefkin was stationed for this purpose for several months at Superior, Wis., on behalf of the Office of Indian Affairs.

Among the results of the fuel investigations during the year was the fact that the purchase of over half of the coal used by the Government was based on some form of specification prepared by the technologic branch. During the year 7,300 samples of coal were received from government buildings and were analyzed, and on the basis of these analyses the payments for the coal were made. Of the samples collected, 2,800 were taken from coal delivered in the District of Columbia. As indicating the growth of this method of purchasing coal, it may be stated that 611,336 tons were so purchased in 1908-9, estimated to cost $1,858,750, and that 829,289 tons were purchased in the present fiscal year (1909-10), at an estimated cost of $2,286,800.

S. S. Voorhees, assisted by J. D. Davis, H. M. Cooper, J. A. Scherrer, William Buttner, W. Alexander, Wood Freeman, H. G. Elledge, and E. G. Borden, was engaged throughout the year in making chemical analyses and tests in Washington of the coals purchased by the Government in Washington and for public buildings throughout the United States.

During the absence of F. M. Stanton on sick leave, A. C. Fieldner, assisted by C. J. Monahan, D. I. Brown, H. Isenberg, W. E. Surbled, and C. K. Glycart, was in charge of chemical analyses of fuels sampled in the mines of the United States. During the year the following analyses and determinations were made: Analyses of gases, 5,000; analyses of mine air, 288; miscellaneous analyses, 556; number of determinations, 14,928.

The field and laboratory study of the chemical and microscopic structure of coal was continued by David White, assisted by Reinhard Thiessen; and field investigations into the character and distribution of peats and certain native coals was continued by C. A. Davis, chiefly in Massachusetts.

These special chemical investigations have added to the knowledge of the character and value of the coal underlying several million acres of public land, and the results were used in the classification of these lands. The samples of coal from the public lands were all collected by members of the geologic branch under M. R. Campbell.

A. C. Fieldner, assisted by G. A. Burrell, was engaged throughout the year in making chemical analyses and tests of natural gas and producer gas.

H. C. Porter, assisted by F. K. Ovitz, continued special chemical investigations concerning the distillation of typical coals at different temperatures. Mr. Porter carried on through the larger part of the year a series of investigations in cooperation with the Bureau of Yards and Docks, Navy Department, concerning the relative merits of storing steaming coal under salt water, in fresh water, and in air both sheltered and in the open. Investigations relative to the nature and possible means of preventing spontaneous combustion of coals were continued, and in cooperation with the Panama Railroad Company a study was made of the deterioration of coal stored in air in a large pile in the temperature of the Isthmus of Panama. This work included 430 tests and analyses, involving 1,500 determinations.

J. C. W. Frazer, assisted by E. J. Hoffman, continued his chemical research into the hydrocarbons in coal with a view to determining its ultimate chemical composition. Mr. Frazer also carried on a series of investigations and tests relative to the explosibility of coal dust of different degrees of fineness and to the gases evolved from coal, using therefor 205 samples of dust.

I. C. Allen, assisted by A. W. Jacobs, continued his chemical and physical examination into the character and fuel value of the different crude petroleums. This inquiry concerned chiefly the petroleums of California but included also miscellaneous petroleums and petroleum products, with a view to acquiring information desired by the Navy, War, and other departments. In the course of this work 1,500 tests were made.

J. K. Clement, assisted for a portion of the year by L. K. Adams, continued cooperation with Henry Kreisinger and J. C. W. Frazer in investigations of special combustion problems, and assisted W. T. Ray, A. V. Bleininger, R. L. Humphrey, and others in certain investigations requiring his special knowledge of the physics of high temperatures.

Fuel-efficiency investigations in connection with the heating and power plants of the Government were continued with special equipment by Henry Kreisinger and W. T. Ray. Mr. Ray left the service in January, 1910. Steaming tests, including smoke investigations, were made, chiefly on behalf of the Quartermaster's Department, by S. B. Flagg on the horizontal return tubular boiler and certain house-heating boilers. In addition, Mr. Flagg made a number of steaming tests at the heating plants of several bureaus in Washington, including the filtration plant, Government Printing Office, General Land Office, and others. He also, with the assistance of S. S. Voorhees and G. S. Pope, furnished advice to the chief clerk of the Treasury Department concerning problems arising at public buildings in different portions of the United States, especially with relation to the kind of fuel and most efficient manner of preventing or removing boiler-tube scale. In all, this work comprised 240 combustion tests, involving 30,600 observations.

R. M. Strong was engaged during a portion of the year in completing, with the advice and assistance of R. H. Fernald, a report on the tests of small internal-combustion engines. Mr. Strong left the service in May, 1910.

C. D. Smith, assisted by F. E. Woodman, conducted a number of producer-gas tests of coals and lignite, both raw and briquetted, and of a few low-grade coals, including samples of two graphitic anthracites from Rhode Island. In connection with producer-gas investigations 15 tests were made, involving 12,000 observations.

C. L. Wright completed certain large-scale lignite briquetting tests on carload lots from Texas, California, and North Dakota, and continued investigative tests on the small hand press in briquetting lignite and coal at various pressures and temperatures and with and without various proportions of binder.

A. W. Belden was engaged throughout the year in the study of the commercial coking processes and in completing his report on coking and washing tests and formulating a projected series of tests on the use of coke in foundry practice.

Lauson Stone continued throughout the year in charge of all computing for the fuel division, assisted at times by the assistant and junior engineers concerned.

A summary of the work for the fiscal year is as follows: Coal, lignite, peat, and oil, samples 2,317, determinations 16,093; gas mixtures (gallery gas), mine air, natural gas, producer and flue gas, samples 1,456, determinations 4,909; miscellaneous, samples 10, determinations 538.

STRUCTURAL-MATERIALS DIVISION.

The organization of the investigations of structural materials continued during the fiscal year as in the previous year. A change in the phraseology of the legislation provided for "the investigation of structural materials both belonging to and for the use of the United States, such as stone, clays, cement, etc." As construed by the Comptroller of the Treasury, the work authorized by the appropriation is limited to the investigation of such materials as are actual property of the United States and are to be used by the United States. The tests of samples representative of materials submitted by contractors for acceptance by the United States should therefore not be paid for from this appropriation, and in consequence, though the structural-materials division continued to test materials of this nature when submitted through the bureaus of the Government, the purchasing officers of those bureaus have been required to reimburse the structural-materials appropriation for the expense involved. The more important laboratory for the investigation of materials of this nature is that at Northampton, Pa., where cement purchased by the Isthmian Canal Commission is tested to ascertain its acceptability. Cement submitted for use in navy-yard and dry-dock construction has been tested at the Pittsburg laboratory, and miscellaneous materials of like kind at the Washington and Pittsburg laboratories.

The structural-materials investigations conducted under the appropriation were carried on chiefly at the Pittsburg laboratory and at the Atlantic City special laboratory. R. L. Humphrey continued in charge of the investigations of cement, concrete, and reinforced concrete, assisted during a part of the year by L. H. Losse and during the remainder of the year by Harry Kaplan, with the aid of E. B. Tolsted, J. G. Bragg, jr., and E. R. Gates. This force was chiefly engaged on investigations of reinforced-concrete beams and columns and a study of the building materials, including chiefly the aggregate for concrete, sent in by the field force, as well as on special investigations for the Isthmian Canal Commission and the Navy, War, and Treasury departments. During the year 13,000 briquet samples were made and 13,500 tests completed on sand, gravel, cement, clay, concrete, reinforced-concrete beams, etc.

The chemical research associated with the investigations of structural materials was conducted by P. H. Bates, assisted by H. H. Phillips and G. E. Webster. The most important problems occupying the attention of this force during the year were those connected with the effect of alkaline soils and waters on concrete and clay products, the effect of sea water on similar materials, and the waterproofing properties of asphalts and coal tars. During the year 1,700 mineral samples were tested and 6,500 determinations were made; and 350 tests and 1,500 analyses were made for government departments.

The investigations of clays and clay products for use in government buildings were conducted at Pittsburg by A. V. Bleininger, assisted by H. E. Ashley, G. H. Brown, and R. K. Hursh, and included chiefly studies of the durability of fire brick when exposed to high temperatures and placed under compressive strain at such temperatures and of the drying properties of clay and the best temperatures for burning it to produce building materials. In cooperation with the States of Arkansas, Texas, and Oklahoma, a study was made of the most efficient means of preparing clay products from indigenous clays so as to make them most suitable for use in public building construction.

During the year the following tests and investigations on clays were conducted:

Crushing strength of clay	1,000
Fire-brick tests	650
Colloid matter of clay	300
Drying investigations	80
Burnt-clay investigations	1,800
Miscellaneous investigations	1,500
	5.330

Under the direction of A. V. Bleininger, assisted by W. E. Emley, investigations of lime, caustic and hydrated, including studies of the methods of burning it, were conducted to determine the types of lime locally available for public building construction and the methods of mixing and proportioning them with sand to make mortar of greatest compressive and tensile strength.

The following work pertaining to lime was done during the year:

Lime plants inspected	14
Density determinations on limes and limestones	200
Lime briquets made for determining compression strength	1,100
Lime briquets made for determining tensile strength	400
Miscellaneous tests	750

The most important investigation conducted by the structural-materials division during the year related to the structural materials most available as to quantity, quality, and location for use in some 400 public buildings authorized by Congress and planned or under construction by the Office of the Supervising Architect. This work was carried on in the States west and south of New England by E. F. Burchard, assisted by J. E. Todd, H. L. Gardner, and J. A. Udden. In New England and portions of New York, Pennsylvania, and a few of the Southern States the field work was continued by N. H. Darton, assisted by T. Nelson Dale. J. A. Holmes assisted in this work at intervals in different parts of the United States. Every quarry furnishing building stone or stone for screenings for use in concrete and numerous gravel and sand pits and brick and tile works were examined; notes were made as to their capacity, output, transportation facilities, and market prices; and samples were collected and forwarded to the Pittsburg laboratory for investigation. Reports of the field investigations were submitted to the Supervising Architect. The materials sampled have been retained for future examination at such time as the Treasury Department may call for additional information regarding them, and in a number of cases the necessary investigations have, on request, been made and the results reported.

The investigations at the Atlantic City laboratory relative to the behavior of concrete exposed to salt water were continued by R. J. Wig under the supervision of R. L. Humphrey. During the year shipments of iron cement from Germany and of cement ground with tufa from California were procured, and these materials were investigated along with typical Portland cement. In addition to these investigations on behalf of the Navy and War departments, a similar series of related investigations concerning the effect of salt water on reinforced-concrete piles for use by the Panama Railroad and the Isthmian Canal Commission were commenced.

The following work was done during the year:

Cement cylinders made and tested	1,000
Cement briquets made and tested	2,100
Other tests	350

A study of the effect of paint, chiefly mineral pigment, as a preservative of structural materials was commenced by S. S. Voorhees, at the request of the Supervising Architect. During a portion of the time Mr. Voorhees was assisted by H. A. Gardner. This investigation included analyses of the pigments and of the oil. The paint was applied to various steel and iron plates, also to such plates when coated with protective coverings of zinc, tin, etc. These plates were exposed to atmospheric action at the Atlantic City laboratory and a record was kept of their behavior.

The testing of cement for the Isthmian Canal Commission under the supervision of R. L. Humphrey was continued at the Northampton laboratory for a portion of the time under W. A. Campbell; later by A. D. Gates. That for the Navy Department was commenced and is in progress at Pittsburg under E. B. Tolsted and T. N. Holmes. The following work was done during the year:

Bins sampled	250
Briquets made	95, 500
Samples taken	11, 000
Briquets tested	87, 500
Soundness pats made	44, 000
Time of set tests	11, 000
Specific-gravity tests	10, 000
Fineness tests	10, 500

At the Washington laboratory investigations of structural materials purchased for use by the several branches of the Government were continued under the direction of S. S. Voorhees and G. O. Spitler, assisted by A. C. Nothstine, J. G. Fairchild, F. H. Tucker, and others. For the Treasury, War, and other departments of the Government 4,500 samples were received and tested.

PUBLICATION BRANCH.

BOOK-PUBLICATION DIVISION.

SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 4 professional papers, 47 bulletins, 9 advance chapters from two other bulletins, 18 water-supply papers, 1 annual report on mineral resources for 1908 (also published in 48 advance chapters), and 6 geologic folios. These publications were the Thirtieth Annual Report; Professional Papers 64 to 67; Bulletins 360, 377, 380, 2 separates from 381, 382 to 424, 428, and 7 separates from 430; Water-Supply Papers 227, 232 to 236, 238, 239, 241 to 245, 247 to 250, and 252; Mineral Resources for 1908 (volume and 48 separates); Geologic Atlas, folios 167 to 171 and 173 (published in folio and octavo forms). Titles and summaries of these publications are given on pages 15–24. In addition to the publications of the regular classes the following were issued: A list of maps illustrating physiographic types; 2 circulars on permissible explosives; a pamphlet entitled "Cooperation between the United States and various States in topographic, hydrographic, and geologic work;" and Press Bulletins 389 to 427 (also 6 special issues). The total number of pages in these publications was 12,855; for the year 1908–9 the number of pages was 10,180.

During the year 29,257 pages of manuscript were prepared for printing and proof sheets for 12,517 final printed pages were read and corrected, this work involving the handling of 4,893 galley proofs and 28,005 page proofs. The corresponding figures for last year were 19,775 pages of manuscript, 11,840 final printed pages, 4,139 galley proofs, and 23,748 page proofs.

Indexes were prepared for 56 publications, covering 10,782 pages, the corresponding figures for last year being 47 publications and 9,730 pages.

The copy and proofs of all account and record books and blanks, circulars, office cards, etc., are examined in this section. This work consumes a large part of the time of one person, but it is not practicable to report the amount statistically.

The personnel of this section consists of the editor, the assistant editor, three editorial clerks, and one stenographer and typewriter.

The division of mineral resources and the water-resources branch have continued to render special assistance in copy preparing and proof reading.

During the year members of the section of texts have at various times cooperated with the section of distribution.

SECTION OF ILLUSTRATIONS.

During the year 3,382 illustrations were prepared and most of them were transmitted to accompany 42 bulletins, 17 water-supply papers, 3 professional papers, 1 monograph, 1 annual report, and 1 report on mineral resources. These illustrations included 250 maps, 744 diagrams, 1,674 paleontologic drawings, 2 landscape drawings, 478 photographs retouched, and 234 miscellaneous.

Proofs to the number of 1,720 were received and compared critically, and the printed editions of all illustrations furnished by contract during the year were examined.

During the year 272 electrotypes were furnished to outside applicants; the number furnished last year was 109.

At the close of the year material for the illustration of 37 reports is in hand.

The personnel of the section consists of ten draftsmen (including the draftsman in charge) and one copyist clerk.

SECTION OF GEOLOGIC MAPS.

During the year 1909–10 six folios (Nos. 167 to 171 and 173; see pp. 23–24) were published, in both folio and octavo (field) editions. The maps for the Warren (Pa.), Johnstown (Pa.), Sewickley (Pa.), and Birmingham (Ala.) folios were also printed and these folios will soon be issued. In addition the following folios were received for publication during the year and are in various stages of engraving and editing: Bismarck, N. Dak.; Burgettstown-Carnegie, Pa.; Burnet-Llano, Tex.; Claysville, Pa.; Ellijay, Ga.-N. C.-Tenn.; Foxburg-Clarion, Pa.; Hollidaysburg, Pa.; Pawpaw-Hancock, W. Va.-Md.-Pa.; Raritan, N. J.; Van Horn, Tex.

The geologic map of North America was completely revised and prepared for publication, and its engraving was begun.

SECTION OF TOPOGRAPHIC MAPS.

On June 30, 1910, there were in the custody of the editor of topographic maps 40 new topographic atlas sheets and special maps which had not yet been put into the hands of the engravers, and 57 maps were in process of publication. The corresponding figures on June 30, 1909, were 76 and 59. During the year 56 new maps were received for publication, 1 map was withdrawn, and 93 maps were published.

The manuscripts edited comprise 88 new topographic atlas sheets and special maps; corrections for 371 sheets hitherto published; 2 maps published under contract; and 168 map illustrations which are or will be included in 27 volumes of Geological Survey reports. The proof read comprises 90 new maps and corrections to 103 maps.

Compilations were made for a revision of the large United States base map (49 by 76 inches) and the copy was prepared for engraving. The revision and correction has been completed and an office edition in nine sheets printed. The three-sheet sale edition was in press at the close of the year. For a new edition of the pamphlet "Topographic maps and folios and geologic folios" the lists of topographic maps were completed to date and each item of the old lists was verified or corrected.

Five men were engaged in the work of this section during the entire year.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 128 new books, 6 folios, 93 new maps, 7 revised maps, 2 photolithographs, and 369 reprints of maps, a total of 605; the totals of all editions were 571,175 books, 28,541 geologic folios, 184 topographic folios, and 1,238,307 maps; grand total, 1,838,207. During the year 508,917 books, 36,139 folios, and 593,622 maps (including 478,737 sold), a total of 1,138,678, were distributed.

The total amount received and turned into the Treasury as a result of sales of publications was $21,202.55 (of which $20,606.35 was from sales of topographic and geologic maps), an increase of $1,303.27 over the amount received in the fiscal year 1908–9.

During the year 95,877 letters were received, answered, and filed, an increase of 22,562 over the number in the preceding year.

Fifteen persons are engaged in the work of this section.

DIVISION OF ENGRAVING AND PRINTING.

MAPS, FOLIOS, AND ILLUSTRATIONS.

At the beginning of the year 135 atlas sheets and special maps were on hand for publication and the accessions during the year were 56 maps. The status of these 191 maps on June 30, 1910, was as follows:

Published during the year	93
Withdrawn from publication	1
In press	21
In process of engraving	36
Not taken up	40

Besides the engraving of new maps, corrections were made on the plates of 371 maps hitherto published. Editions of 469 maps, including new sheets and reprints, were printed and delivered to the map room.

Six geologic folios were published, and 28,541 copies were delivered. One geologic folio was in press at the close of the year and six others had been partly completed.

Under contracts with the Government Printing Office, illustrations were printed for the following Survey publications: Bulletins 381, 390, 398, 406, 407, 408, 410, 415, 416, 427, 432; Professional Papers 66 and 68; Water-Supply Papers 220, 221, 231, 234, 237; Mineral Resources, 1908; Thirtieth Annual Report of the Director; and Stadia Tables. For the Government Printing Office, also, the following items were printed and delivered: Maps to illustrate the American Ephemeris and Nautical Almanac, Annual Report Chief Signal Officer U. S. Army, Annual Report Commissioner of Indian Affairs, Annual Report Department of the Interior, Annual Report Isthmian Canal Commission, Annual Report Superintendent Mount Rainier National Park, Engineers' Field Manual U. S. Army, Twenty-first Annual Report on the Statistics of Railways, and 29 House documents and Senate reports; illustrations for Forest Service Form 979 and General Land Office Form 4–675a; sketching sheets for Forest Atlas; sectional township blanks; maps of 9 national monuments and reservations; and homestead maps of States and Territories. The following work was done for other government departments and bureaus: For the Forest Service, maps of 46 national forests, diagrams for 27 national-forest proclamations, Forest Atlas legend page, two maps of North America showing natural-forest regions, map of national forests and related projects and data, statistical diagrams and illustration for supervisor's report; for the General Land Office, 1,605 township plats; for the Department of the Interior, maps of three national parks; for the Reclamation Service, War Department, Office of Indian Affairs, Isthmian Canal Commission, Smithsonian Institution, Civil Service Commission, Biological Survey, Weather Bureau, Interstate Commerce Commission, Bureau of Soils, Army Service Schools, and Bureau of American Ethnology, a large amount of miscellaneous work. This work for other branches of the Government amounted to about $45,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Of contract and miscellaneous printing of all kinds the total number of copies delivered was more than a million and a third and required nearly three and one-half million printings. The total number of copies printed, including topographic maps and geologic folios, was 2,604,666, requiring over nine and one-third million impressions. On requisition of the Government Printing Office 796 transfer impressions were made and shipped to contracting printers.

INSTRUMENT SHOP.

The work of the instrument shop consisted in overhauling and repairing surveying, drafting, and engraving instruments and making copperplates and electrotypes. More than 3,000 repairs were made to instruments and 375 new copperplates and 22 electrotypes were finished.

PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory included 10,260 negatives, of which 2,884 were wet, 648 paper, and 6,728 dry; and 25,337 prints, of which 8,994 were maps and 16,343 matte prints.

ADMINISTRATIVE BRANCH.

EXECUTIVE DIVISION.

Correspondence, records, appointments, supplies, and shipments.—The work of this section during the year continued along the lines previously followed, the only change being in the method of granting leave without pay. In accordance with instructions from the Secretary dated May 13, 1910, all applications for such leave are referred to the department for action instead of being passed on by the chief clerk of the Survey. The volume of work performed in this section has increased in almost every item.

Mails, files, and records.—During the year 132,182 pieces of incoming mail were handled in this section, a gain of nearly 9 per cent over the preceding fiscal year. The gain in 1909 over 1908 was more than 13 per cent. Of this mail 2,348 pieces were registered and 25,670, an increase of 1.6 per cent over the preceding year, contained remittances for publications of the Survey. The amount of money received in this mail was $23,858.86, an increase of 5.8 per cent over 1909.

The recording, referring, and filing of correspondence required the services of four clerks through the year. The number of letters mailed through the section was 85,307, an increase of 6.7 per cent over the previous year. Of this number 12,120 were registered.

Personnel.—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 958 persons, compared with 955 at the close of 1909. Although the total number is thus practically the same, the number of changes in the personnel was 1,083 during the year. These changes included original appointments, separations, promotions, extensions, and changes of status of every description. Of these 296 were new appointments, or accessions, 293 were separations, 377 were promotions, 5 were reductions, and the remainder extensions of limited appointments, changes in titles or in the basis of payment, the designation of disbursing agents, and such other minor changes as neither increased nor decreased the total number of persons.

During the year 16,358 days of annual leave and 2,938 days of sick leave were granted, being about 55 per cent of the amount of annual leave and 11 per cent of the amount of sick leave which it is permissible to grant under the law; 15,613 days of leave without pay were also granted. These figures show considerable increases, the leave without pay being 127 per cent higher than last year. There were also 111 transfers to state pay rolls, in cooperative work.

Property accountability.—During the year the system of property accountability by custodians for various branches and divisions was continued, with a custodian of office property. An inventory of all nonexpendable property in Washington was submitted to the department at the close of the calendar year 1909.

Express and freight.—During the year 4,472 pieces of freight and express were handled by the shipping clerk, of which 1,043 were outgoing and 3,429 incoming; 567 freight and express accounts were examined and checked. This is an increase of 35 per cent in the number of pieces handled, but a decrease in the number of accounts checked.

Purchase and distribution of supplies.—During the year three persons were engaged in the purchase and distribution of supplies, which includes the procuring of bids, the issuing of orders, and the preparation of vouchers covering all purchases in the open market. The number of requisitions handled was 2,015; this was a decrease of 29 per cent from 1909, but in that year the number was abnormally large because of the two fires that necessitated the replacing of destroyed property.

Stationery.—In the stationery room the services of three men are required in handling the mails, packing and shipping supplies to field parties, keeping an account of the charges for stationery supplies, and making requisitions on the department for printing and supplies. During the year 6,740 requisitions for blanks, blank books, and miscellaneous supplies were filled from stock on hand, and 302 requisitions were drawn on the department for stationery supplies, 505 for printing, and 317 for furniture and miscellaneous supplies. These figures are all smaller than the corresponding ones for 1909.

Administrative bookkeeper.—During the year the administrative bookkeeper, in addition to his regular duties, was put in charge of the bookkeeping of the division of disbursements and accounts, economy of work and expense being effected by this arrangement. He continued to handle all Survey transactions of an administrative character, passed on all requisitions for supplies to be procured from the Department of the Interior, and verified and prepared for settlement the accounts covering charges thus arising against Survey appropriations.

The following table gives the classified net expenditures by the Survey for the fiscal year 1910, the repayments shown in the table on page 123 having been deducted:

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1910.

Appropriation.	Total.	Salaries and wages.	Traveling expenses.	Rent, electric light, and motive power.	Office furniture and fixtures.	Stationery supplies.	Library.	Transportation of property.	Instruments.	Telegrams and telephone service.
Salaries, statutory	$64,339.71	$64,339.71								
Skilled laborers, etc	19,999.51	19,999.51								
Gaging streams, etc	98,896.49	78,775.51	$8,347.22	$2,407.16	$1,114.60	$1,057.21		$334.55	$1,681.11	$287.44
Chemical and physical researches	19,939.18	18,809.20	25.50	342.18	5.00	34.72		12.83		
Preparation of illustrations	17,153.82	15,784.43			13.96	326.77		.50		18.33
Mineral resources of the United States	74,252.45	64,683.77	3,897.11	555.80	542.30	1,138.02	$4.20	170.34	17.55	832.60
Books for the library	1,143.48						1,134.68	8.80		
Topographic surveys	347,311.29	234,909.22	24,994.69		1,151.77	5,318.52	2.70	7,719.03	4,559.76	401.40
Geologic surveys	221,285.57	179,942.38	11,814.19	154.99	1,884.85	2,138.11		1,682.89	1,097.27	305.91
Mineral resources of Alaska	89,640.12	55,205.78	12,989.72	25.00	815.41	271.73		5,696.63	642.66	75.90
Replacing articles destroyed by fire	338.43									
Geologic maps of the United States	87,476.20	72,979.20	767.37	2,137.38	34.85	289.93		73.10		46.89
Surveying forest reserves	74,452.80	50,733.34	4,445.66		150.00	501.76		1,524.37	199.08	42.15
Testing fuel	99,661.84	85,618.43	1,898.99	657.46	192.19	323.33	142.27	1,310.61	17.85	228.07
Testing structural materials	91,494.80	65,249.20	3,854.64	485.22	68.67	208.49	248.80	1,253.43		186.67
Inspecting mines in Territories	3,064.80	1,999.99	524.81							
Investigating mine accidents	149,510.43	119,830.36	5,877.44	3.08	510.96	426.39	129.60	974.25		248.24
	1,459,960.92	1,128,810.03	79,437.34	6,768.27	6,484.55	12,034.98	1,662.25	20,761.33	8,215.28	2,118.60

Classification of expenditures by the United States Geological Survey for account of the fiscal year ending June 30, 1910—Continued.

Appropriation.	Camp outfit.	Subsistence.	Forage.	Photographic material.	Engraving and printing material.	Chemical and physical laboratory material.	Drawing material.	Control material.	Erection of testing plants.	Operation of testing plants.
Salaries, statutory										
Skilled laborers, etc										
Gaging streams, etc	$450.93	$2,651.75	$368.30	$844.44		$487.91	$93.36			
Chemical and physical researches		8.75		4.20		694.16	2.64			
Preparation of illustrations				749.50			265.34			
Mineral resources of the United States	14.25	2,176.18	10.70	244.89		512.31	2.43			
Books for the library										
Topographic surveys	12,709.90	32,024.74	16,403.45	3,038.34		27.85	1,266.70	$2,783.22		
Geologic surveys	2,029.15	11,218.92	2,735.14	3,548.77		2,187.22	543.78	2.00		
Mineral resources of Alaska	5,703.61	6,320.82	1,055.34	577.86		87.00	172.66			
Replacing articles destroyed by fire						338.43				
Geologic maps of the United States		306.37		529.90	$10,311.21					
Surveying forest reserves	2,780.59	9,771.57	8,916.82	301.60			38.10	47.76		
Testing fuel		1,183.61		179.94		3,282.53	45.00		$2,708.09	$1,873.47
Testing structural materials		3,488.27		268.68		964.99	12.97		12,361.24	2,893.53
Inspecting mines in Territories		540.00								
Investigating mine accidents		4,396.07	.25	464.05		5,507.88	4.20		6,231.26	4,906.40
Total	23,688.43	74,087.05	24,485.00	10,762.17	10,311.21	14,090.28	2,447.18	2,832.98	21,300.59	9,673.40

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below.

Amounts appropriated for and expended by the United States Geological Survey for the fiscal year ending June 30, 1910.

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of the Director.	$34,860.00	$5.00	$34,865.00	$34,444.81	$420.19
Salaries, scientific assistants.	29,900.00	81.75	29,981.75	29,981.65	.10
Skilled laborers, etc..........	20,000.00	....	20,000.00	19,999.51	.49
Gaging streams, etc..........	100,000.00	28,268.64	128,268.64	127,165.13	1,103.51
Chemical and physical researches..................	20,000.00	....	20,000.00	19,939.18	60.82
Preparation of illustrations..	18,280.00	16.67	18,296.67	17,170.49	1,126.18
Mineral resources of the United States.............	75,000.00	23.64	75,023.64	74,276.09	747.55
Books for the library........	2,000.00	....	2,000.00	1,143.48	856.52
Topographic surveys........	350,000.00	44,287.46	394,287.46	391,598.75	2,688.71
Geologic surveys............	225,000.00	34,246.57	259,246.57	255,532.14	3,714.48
Mineral resources of Alaska..	90,000.00	65.16	90,065.16	89,705.28	359.88
Replacing articles destroyed by fire......................	425.00	....	425.00	338.43	86.57
Geologic maps of United States.....................	100,000.00	54,013.11	154,013.11	141,489.31	12,523.80
Surveying forest reserves....	75,000.00	49.20	75,049.20	74,502.00	547.20
Testing fuel.................	100,015.38	4,264.55	104,279.93	103,926.39	353.54
Testing structural materials.	100,000.00	23,793.02	123,793.02	115,287.82	8,505.20
Inspecting mines in Territories.....................	7,350.00	....	7,350.00	3,064.80	4,285.20
Investigating mine accidents.	150,000.00	8,127.15	158,127.15	157,637.58	489.57
	1,497,830.38	197,241.92	1,695,072.30	1,657,202.84	37,869.46

LIBRARY.

The library received during the year 11,563 book publications and 851 maps. The accessions record shows a total of 69,778 volumes; of this number 3,972 volumes have been transferred to the Library of Congress or otherwise disposed of, leaving 65,806 now on hand. The estimated number of maps is 35,800 and of pamphlets 85,000. During the year 8,010 volumes and 980 maps were catalogued.

Constant care is exercised to procure, as nearly as possible, all new original works of geologic interest and such as are needed of the more recent publications in the fields of the related sciences. Some additions have also been made to the earlier literature of geology and paleontology, thus increasing the value of the library for reference purposes.

The number of visits to the library during the year was 8,578, and 12,340 books and 547 maps were loaned for use outside of the library.

In order to bring up to the authorized quota of 500 the distribution of geologic folios and at the same time to place these folios where they may serve the widest educational needs, letters were sent to about 150 selected libraries in various parts of the world stating that the folios were available under certain conditions. As a result of these negotiations over 15,000 folios which had accumulated in the stock rooms have been distributed to the libraries of universities, mining schools, and other institutions where they were desired.

The bibliography of North American geology for 1908 was completed, proof read, and issued as Bulletin 409. The corresponding volume for 1909 (Bulletin 444) is well advanced.

The Survey exchange list at present consists of 910 addresses, all of institutions. To these, 62,762 volumes of Survey publications were distributed.

The correspondence consisted of 3,327 letters received and 3,364 letters written, and 82 letters and other papers were translated in the library for the use of other divisions of the office.

The personnel of the library consists of the librarian, the assistant librarian, two cataloguers, and three other persons.

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